ARCHITECTURE DEPARTMENT

MASTER OF ARCHITECTURE PROGRAMME

CHINESE UNIVERSITY OF HONG KONG

2009-2010 DESIGN REPORT

PARAMETRIC VARIATION IN ARCHITECTURE

WONG Chui Kwan, Alice May 2010

Part III

research . project . process

School of Architecture, The Chinese University of Hong Kong . Thesis Report . WONG Chui-kwan Alice . 2009 - 2010

Parametric Variation in Architecture

from **Designing Parameter** to **Parametric Design**

Sep-Dec 2009 // Part I
Research and Experiment : Designing Parameter

Jan-Apr 2010 // Part II
Architectural Project : Parametric Design

Parametric Variation in Architecture

from Designing Parameter to Parametric Design

This is a thesis started from asking a seemingly ignorant question: "What is parametric design?" To tackle this, it is necessary to look into its fundamental, which I believe, is formulating a description of a dynamic process changed by a set of variables (parameters) to generate variations. The thesis is to explore the parametric variation for achieving complexity of spatial organization.

As a testing ground, a design exercise was firstly carried out to investigate how to "design parameter". A "machine" for calculating view openness percentage was developed for the generation of possible variations in a typical residential tower. A more complex scenario was chosen then to demonstrate an integrated design process with parameters at multi-levels, to accomplish an authentic "parametric design" with variety of spaces for a student hostel. The thesis is a critic on current phenomenon of computational designs and recognizes that interpretation of parametric data is crucial to avoid designs from merely being stylish as an image of indexing architecture. Lastly, an animation documenting the design making was produced to communicate with public how dialogue between machine and human was synchronized for design aspirations.

Part I

theoretical research . design exercise

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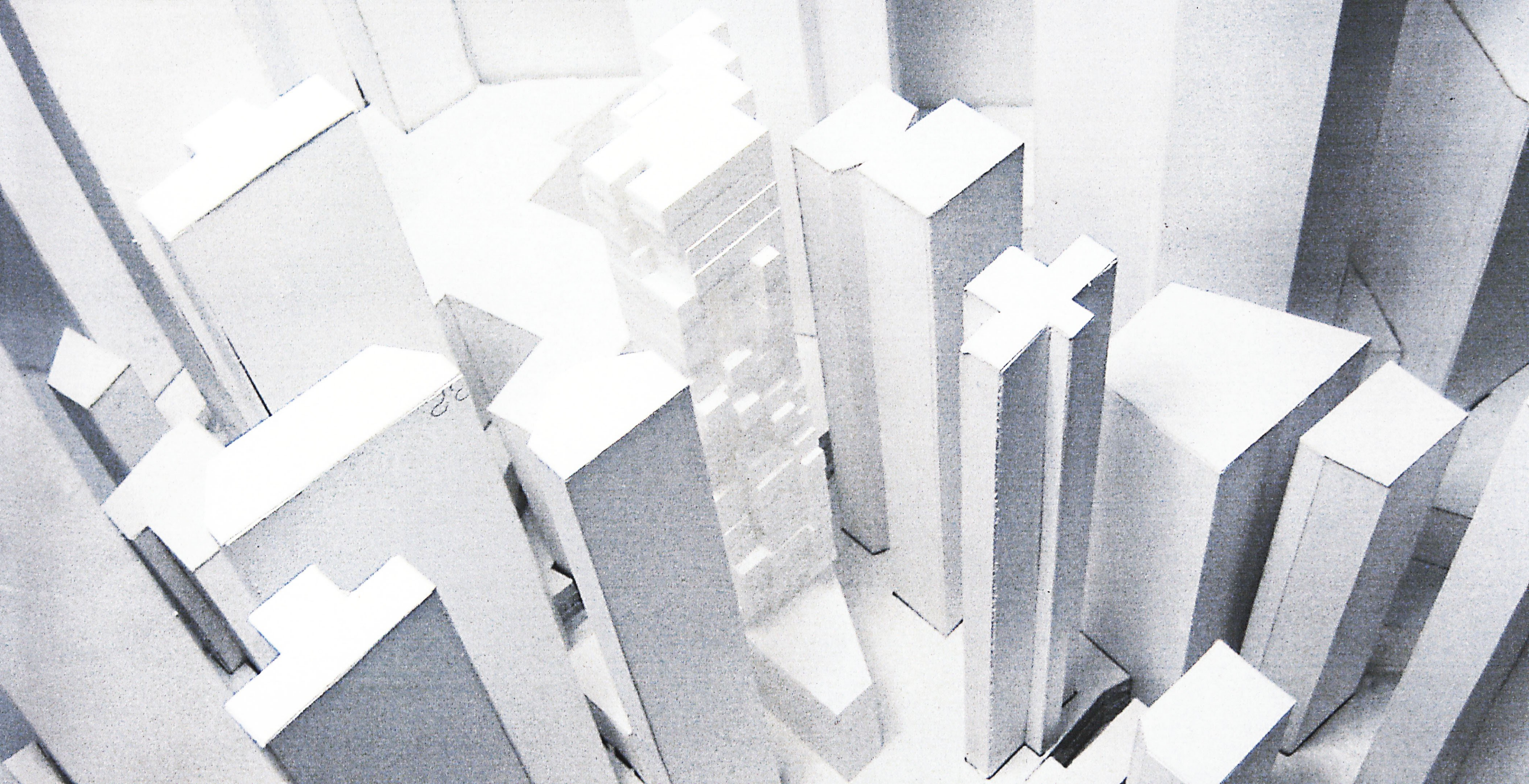
Parametric Variation in Architecture

from **Designing Parameter** to Parametric Design



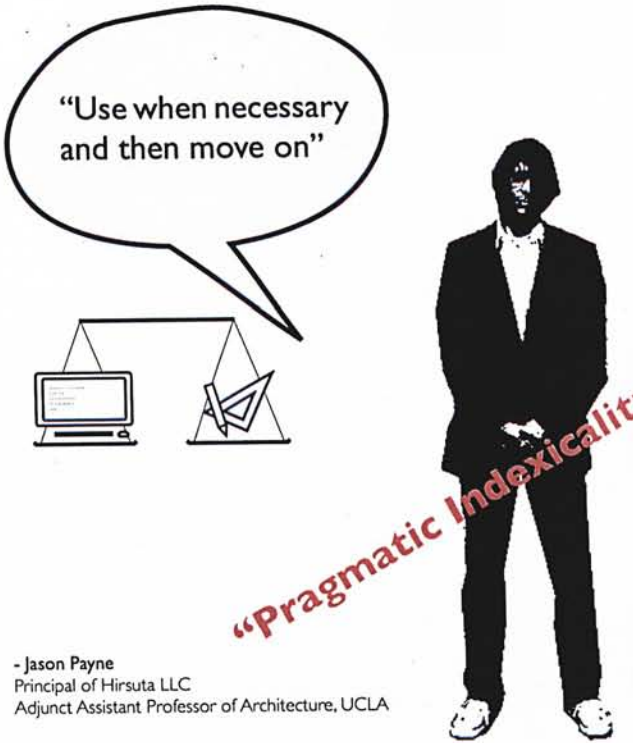
INTRODUCTION

What is parametric?

Critics & Doubts
Thesis Statement
Thesis Components


RIC
ARCHITECTS

\\Critics & Doubts

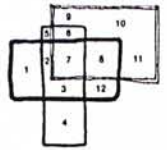


What is PA.....RA.....METRIC.....

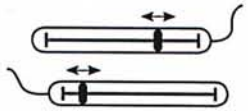
\\Thesis Statement & Components

The **fundamental of parametric design** is formulating a description of a dynamic process changed by a set of variables (parameters) to generate **VARIATIONS**. My thesis is to explore the **PARAMETRIC VARIATION** for achieving complexity of spatial organization.

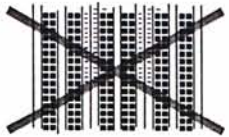
Architectural Issue	Strategies	Problems/Scenarios
Complexity of Spatial Organization by **PARAMETRIC VARIATIONS**	Parametric Computational Tools e.g. Grasshopper to design **SPATIAL PARAMETERS**	To cope with **LARGE QUANTITY** of variations in architecture



+ Review the fundamental of Parametric Design as a way to generating variations



+ Redevelop an alternative methodology for doing parametric design



+ Research architectural ideas by design - to see how to translate the parametric concept into architecture after the investigation

THEORETICAL RESEARCH

Terminology

Parametric
Parametric VARIATION
Parametric COMPLEXITY
"range"
"correlation"
"ambiguity"

Parametric Architecture

Parametric Benefits
Logic, Factor & Parameter
Levels of Variation
Precedent Study

Parametric Tool

Rhinoceros Grasshopper
Tutorial Examples

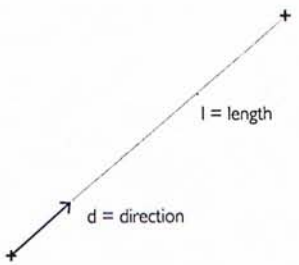
PARA ·MET ·RIC ad \pa-rə-'me-trik\

para-
+ a prefix most often attached to verbs and verbal derivatives, with the meanings "at or to one side of, beside, side by side" (parabola; paragraph; parallel; paralysis)

metric
+ n. a standard of measurement.
+ n. a geometric function that describes the distances between pairs of points in a space. (Maths)
+ adj. of or relating to distance.

PARAMETER n.

parameter is a constant or variable term in a function (parametric equation) that determines the specific form of the function.



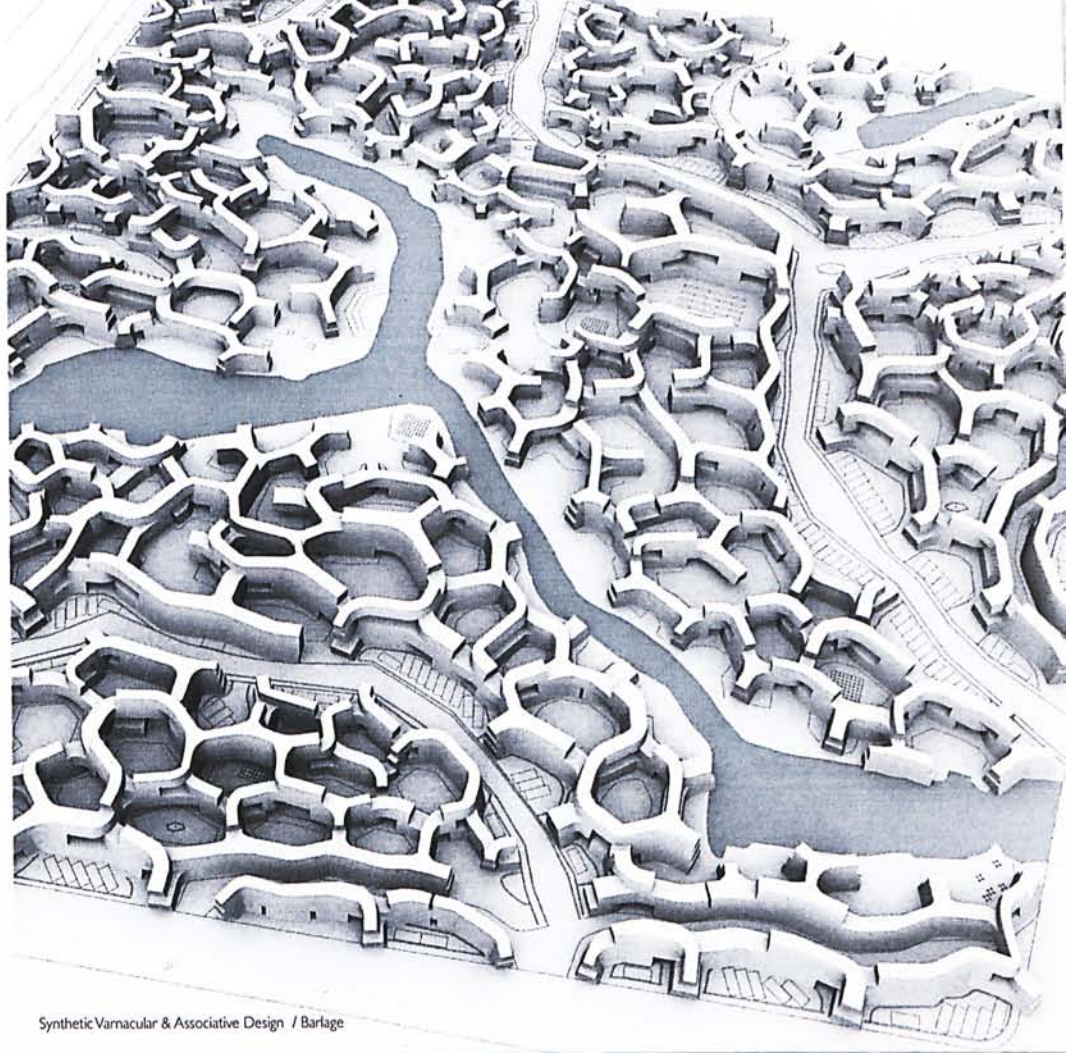
parameter of a staight line

Option 1
+ length [distance of 2 (extreme) points]
+ direction [vector of 2 (extreme) points]

Option 2
+ starting point coordinates
+ end point coordinates

\\Definition of Parametric

Parametric can be seen as a descriptive mechanism changed by parameters to generate a series of **variations** as outputs in the process of manipulations.

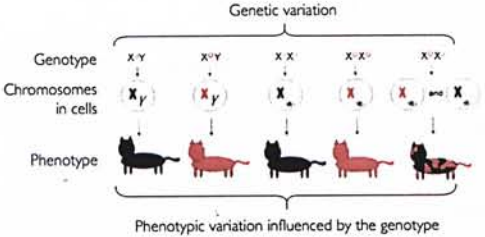


Synthetic Varnacular & Associative Design / Barlage

\\Definition of Variation & its Significance

VAR·I·A·TION n. \ver-ē-'ā-shən\

a : the act or process of varying : the state or fact of being varied
b : an instance of varying
c : the extent to which or the range in which a thing varies



Variation is proved to be important for biodiversity and prcoess of evolution by natural selection in our nature.
COMPLEXITY of variation in nature is contributed by phenotypic variation.

\\Analogy of Complexity between nature and man-made digital realm

Phenotypic variation

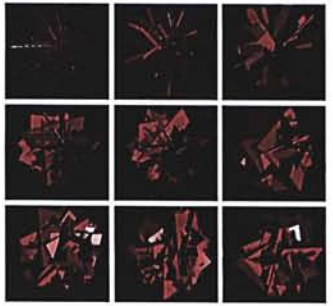
Phenotypic variation is a fundamental product by natural selection in the process of evolution. Phenotype is determined by an organism's genetic make-up (genotype) and the influence of environmental factors and possible interactions between the two. It is an organism's actual observable properties, e.g. morphology or behavior. Not all organisms with the same genotype look or act the same way, because appearance and behavior are modified by environmental and developmental conditions.

So... what may lead to complexity in PARAMETRIC VARIATION >>>

"Range"
(genetic variation)

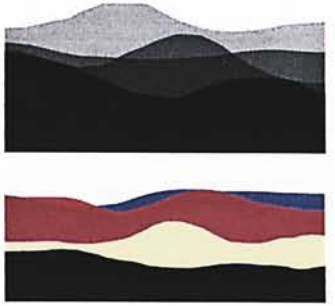
"Correlation"
(environment)

"Randomness"
(random-chance)



Rose / Yugo Nakamura

For each parameter, it is always possible to define its limit, instead of an absolute value, to generate a range of variations. When a compound list of adjustable parameters is created for a design, numerous combinations can be tested out. Playing with the "range" of the parameter sliders, mutation and new types may be evoluted because of the quality of ambiguity which offers multiple readings of things.



Border / Yugo Nakamura

Independent parameters are parameters which do not affect / are not affacted by other parameters in a design. The variations resulted from the independent parameter is always easier to be forseen and predicted. Rather than that, surrounding environment always has interweaving relationship which is controlled by dependent parameters. It is important to take the significant factors into the mechanism.

Uniqlo try / Yugo Nakamura

Randomness is a mechanism to achieve unexpectedness out of a predefined setting and give surprise to the users. Parametric is not necessarily deterministic when the algorithm allow more than one outcome or there are multiple ways to get there and we simply don't care which of them is chosen.

\\Why Parametric?

1 + 1 = 2

1374 x 65203 = ?

Parametric benefits

Nowadays, parametric design becoming a promising and protruding architectural design method is not without reasons and evidences. It is particular strong in development of three aspects - optimization, mass customization and fabrication. Usually, these developments happen at the post-design stages, the parametric technqiues are introduced when the design is more or less finished. It is more a matter of realizing and materializing the design. Of course, many architects are trying to utilize the parametric means as a design tool like Cecil Balmond or Aranda/Lasch. Recently, associative design developed by Berlage Institute demonstrates how to use parametric to develop a master planning in a huge urban context. Parametric design could be said as an advancement of traditional design. Basically, there is always a condition to be fulfilled for an efficient use of parametric design strategy, which is the design itself contains a LARGE QUANTITY set of variations or aims for creating many variations, therefore computer can assist our human brain to process a large amount of data.

Optimization

Kakamigahara Crematorium / Toyo Ito
Implementing Sensitivity Analysis method for minimizing the strain energy and deformation

Data-driven Parametric Design with reconfigurable smart models by capturing the underlying logic can EFFICIENTLY perform changes, as such environmental factors and strcutural factors can be optimized. Modification can be easily made without rebuilding everything from crash again.

Mass customization

Hungerburg Funicular / Zaha Hadid
For the four new stations in Innsbruck more than 2000 meters of custom cut polyethylene profiles connect gass cladding to the steel ribs.

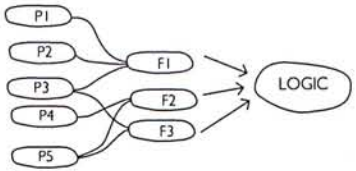
Parametric Design is a SIMPLE, EFFICIENT way to produce differentiated repetition in digital modeling that otherwise requires a great deal of time and effort. Therefore, things are no longer necessary to be standardized.

Machinization

Radiolaria / Christian Troche
Its parametricall defined elements are processed into uniques nodes and members through CNC manufacturing.

With everything digitalized, production can be done by programmed-machines or robotic system. To tailor-make a large amount of varied components is not impossible.

\\Parametric Approach



Logic, Factors & Parameters

To design parametric architecture, we need to define a logic of parameters. Behind each logic, there is always some factors which act as driven forces to stimulate its formation. For each design project, depending on the design concept, certain factors may take a more dominate role. Each factor would then have its specific set of parameters controlling its variations. When multiple layers of parameters and factors interweave together, a more complex logic may result.

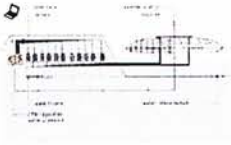
Through the classification study, four main types of factors are clarified, which are fabrication, structure, environment and spatial organization. Under each types, relative parameters are always specific and varied. It is almost impossible to list out all kinds of parameters. In general, one can still observe a prevailing focus of parametric architecture emphasizing construction and structural realization. This may relate to the fundamental strength of parametric design.

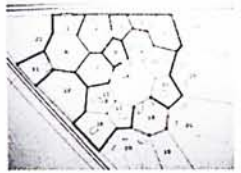
Serpentine Gallery / Alvaro Siza, Cecil Balmond

Kakamigahara Crematorium / Toyo Ito

The Blur Building (Swiss Expo 2002) / Diller Scofidio + Renfro

Hair Salon / Shohei Matsukawa





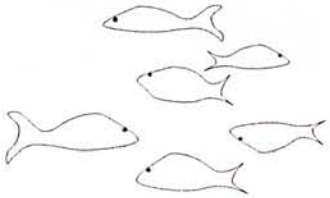
Factor	Fabrication	Structure	Environment	Spatial Organization
Logic	An efficient subdivision system	Minimizing strain energy and deformation	Movement and visibility of fog	Minimizing the distance between rooms and each room has its special orientation and privacy
Parameter	spacing, dimensions, cost	strain energy, stress distribution, degree of curvature	air pressure, temperature, wind speed, humidity, etc	spacing, dimensions, connectivity
Variation as architectural element	external structure	roof structure	atmospherc	internal space

Levels of Variations

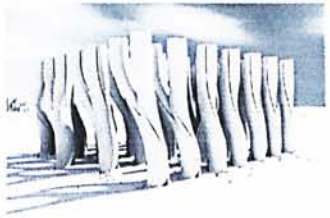
The complexity of parametric variations can be affected by the complexity of the logic. Articulation of relationship between factors and architectural parameters in the logic is a crucial part of parametric design, As a way, complexity should be done by doing less, but achieving more.

Yet, to be more specific about the complexity of spatial organization, it is also necessary to understand that parametric variations in architecture happen at different levels, which can have different spatial organization implications and logical approaches.

Macroscopic variation
A group of instances

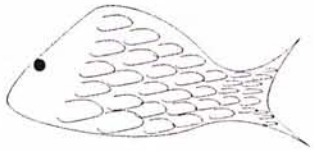


Urban and Spatial Massing
Inter-building Relation



Dubai 49 / University of Applied Arts

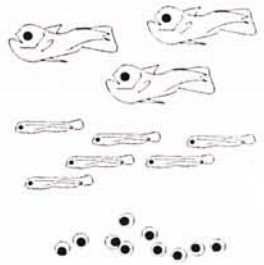
Microscopic variation
As a whole



Architectural Expression
Internal Differentiation

Zeche Zollverein / Kazuyo Sejima & Ryue

Time-base variation
Change with time



Evolving/Transformable/Temporary Architecture

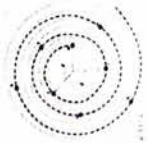
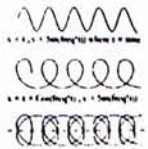
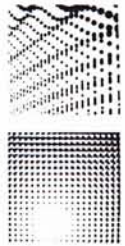
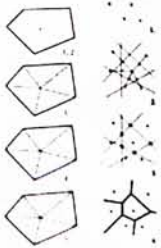
Blur Building / Diller Scofidio + Renfro

\\Precedent Study -
Microscopic Variation

<<Tooling>> / Aranda/Lasch

In order to be able to engage into the parametric interface, a new way of thinking in the operational level has to be adopted. From time to time, those architects are looking for an organizational logic to "parametricize" immaterial / intengible factors, which give architectural design implications.

In comparison to the five points of architecture synthesized by Le Corbusier for the modern movement, a New York base architectural office - Aranda/Lasch has summarized 7 algorithmic "tools" in their book "Tooling". All these "tools" together can be seen as some primitive "organization diagrams" to strcuture information and to establish order and relationship between different parts. These organizations are not completely never seen before, instead they can be traced back to many "non-parametric" architecture. Usually, Parametric logic is also translated from daily examples. The question may be whether "parametric" architecture can give a higher resolution in term of experience and formal expression by being more adpative, sensitive, responive to the surrounding.

	Guggenheim Museum / Frank Gehry	Bamboo Pavilion / Rocco Yim	Signal Box / H&dM	Tomihiro Art Museum / Makoto Yokomizo	Almere / SANAA	
Non-parametric Architecture						
Parametric Architecture	 10 Mile Spiral Aranda/Lasch	 Beijing National Stadium / H&dM	 Sinosteel International Plaza / MAD		 Hair Salon / Shohei Matsukawa	 Serpentine Gallery / Toyo Ito
Tool Diagram						
	Spiraling	Weaving	Blending	Packing	Cracking Tiling	Flocking
Logical Concept	Curvillinear arrangement	Combination of varied curves	Softening the edge / merging 2 regions	Efficient agglormeration occupying minimal surface area	Subdivision of a geometry	Dynamic interaction between agents along the timeline
Architectural Implication	Continuous circulation / Gentle change of levels	Increase multiple connectivity and nodes / stablizing structure	Gradation of space or surface	Non-linear organization	Creation of a group of space and partitions	Traffic flow, city mobility and atmospheric movement

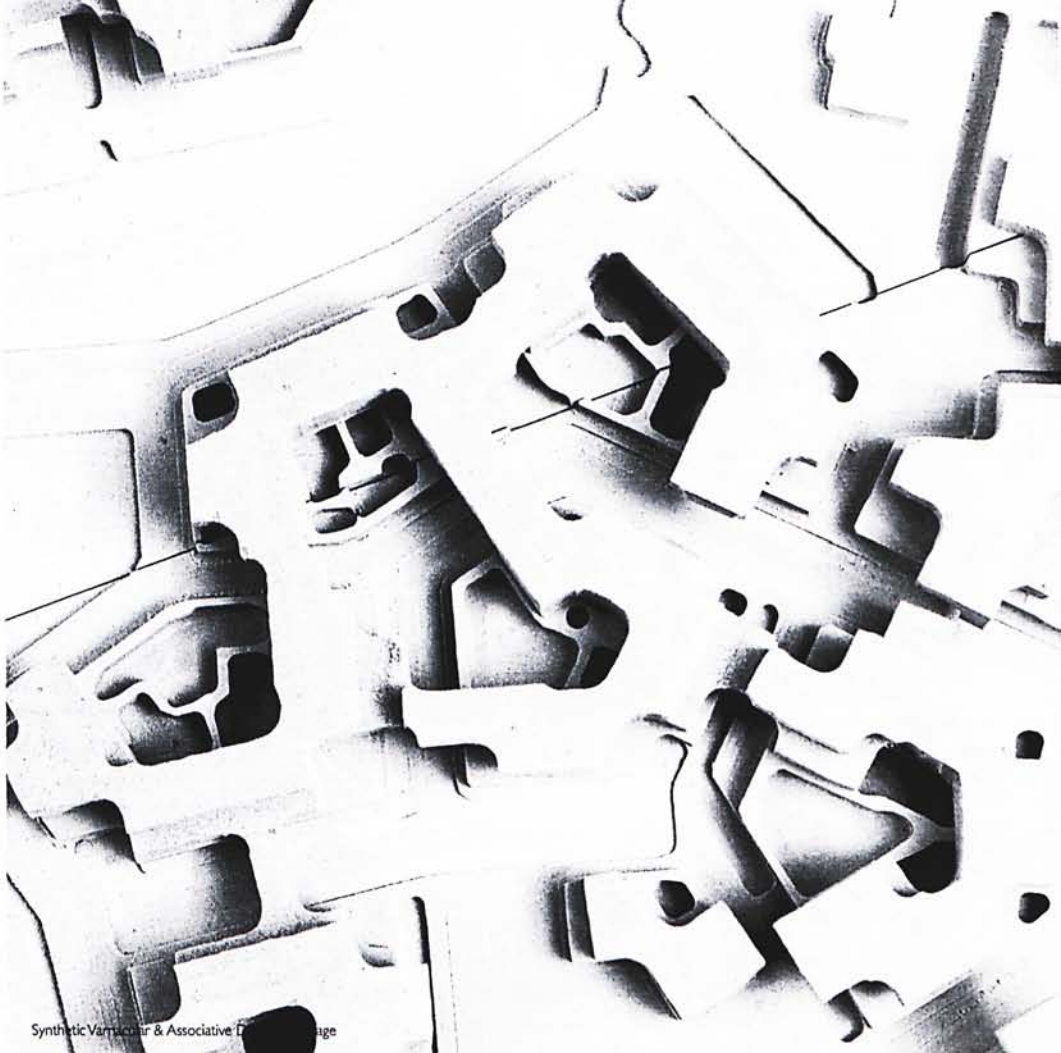
\\Precedent Study -
Macroscopic Variation

Associative Design / Berlage Institute

This is a design research program applies new computational tecniques to the forces of urbanization. The parametric system is applied on 4 levels of relationship - housing unit, facade, cluster and neighbourhood. Each relationship has its own set of factors and parameters.

Comparing to the previous case, the application of this parametric strategy is to generate variation at a macroscopic level. In another word, instead of creating an architectural expression through the parametric logic, the focus is more about the quality of indivdual units (instances) which generate the whole urban massing. By sophisticated and dynamic mechanism, designers can easily test with different combinations by varing the parameters.

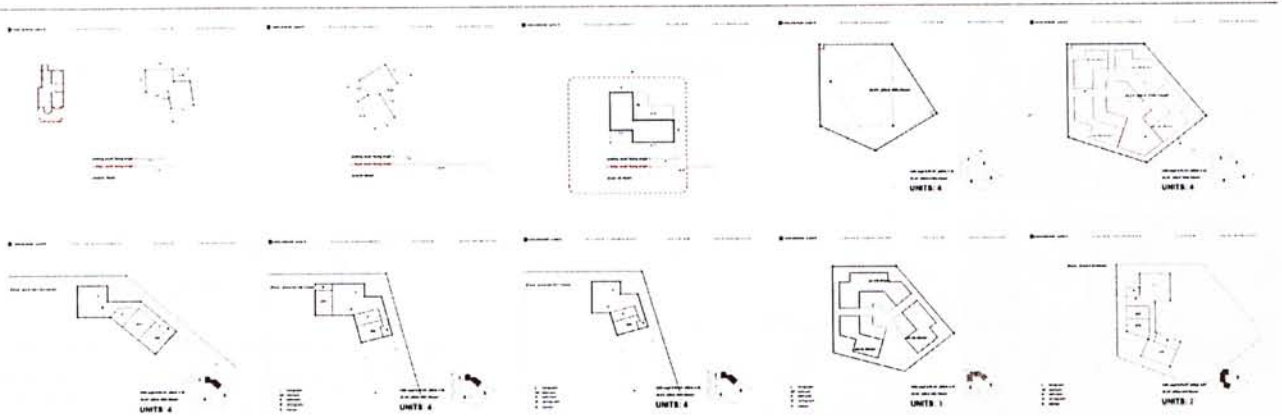
Depending on the intention, architects might have to determine which approach to go with from the very beginning.



>>Associative Design / Berlage Institute

Some partial steps illustrated in the design process

housing unit



1. Define a general layout for a housing unit.

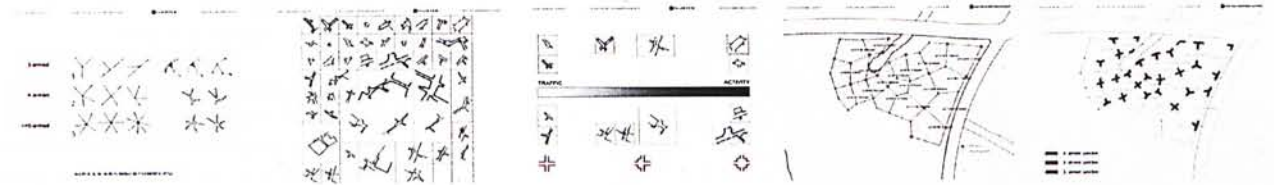
2. Define outer and inner courtyard relationship = L geometry

3, Define a dynamic plot boundary with a hinge point

4. Define max 4 units in a plot but this number can always be adjusted

5. Factors, such as sun shading will be taken into account to define 3-dimensional relationship

cluster



1. Define various types of junction conditions

2. Identify their spatial implications

3. Define their arrangement in the site with specific angle range

neighbourhood

1. Define factors influencing the land value = water and noise

2. Map the site

3.The final arrangement of the housing units is matched with the land value

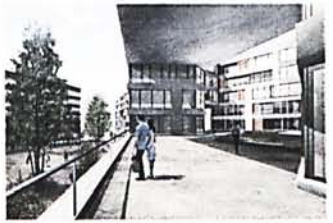
\\Precedent Study -
Macroscopic Variation
non-parametric examples

Do we need to have parametric intention so to be parametric?

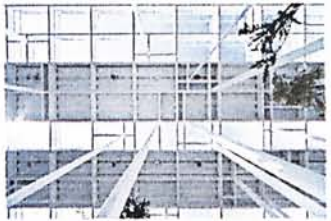
In these two examples on the right, parametric is not being addressed as a strategy for the design. However, the richness of variations created in the design is not incomparable to any parametric architecture. Moreover, in these buildings, the sense of parametric can be said absorbed into the quality of space. Because of the variations, each space acquires its own character and identity.

Just as an idea, is it actually possible to abstract the parameters out and parametricize the design process for the above projects? Another challenging question is ... what if the bulding size is increased by 10 or even more?

"Coop-Areal" /
Marcel Meili, Markus Peter
Architects

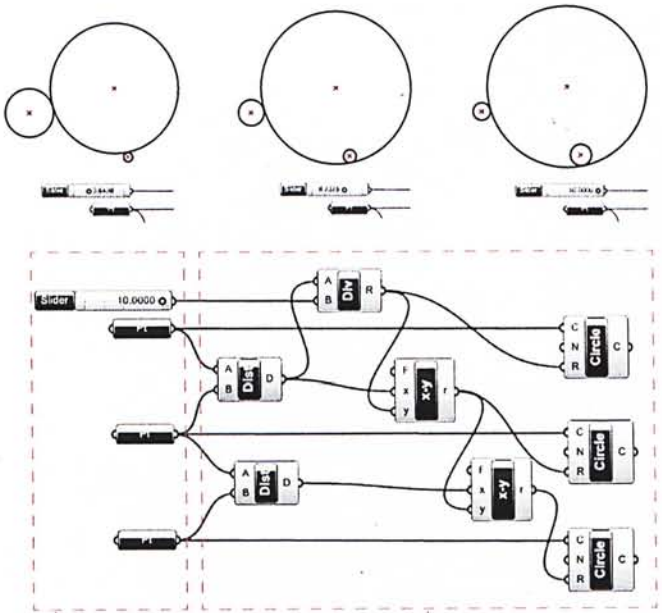


Kait Workshop /
Junya Ishigami Architects



Rhinoceros Grasshopper

For this thesis, the major parametric programme being used is a plug-in of Rhinoceros called Grasshopper. It is a graphical algorithm editor integrated into Rhino's 3-D modeling software. The Reason of using it is that, unlike other conventional types of scripting, Grasshopper requires little knowledge of programming and offer a real-time visualization when making adjustment.



As an example, the logic of this parametric description is to form a relationship among 3 points which are centres of 3 touching circles. The parameter can be varied is the ratio between the radius of the 1st circle and the radius of the 2nd circle. A CHAIN REACTION will then happen onto the whole system. The parameter will also influence the height of each volume. If the points are moved, the result will be updated in real-time.

- PARAMETER
  = contain data/ to store stuff
  e.g. integer (1, 2, 3, 4, 5...)
  floating no. (fractional number)
  string ("Hello World")
  boolean (T/F)
  geometry (points, line, plane...)

- COMPONENT
  = contain action/ to do stuff
  e.g. logic (conditional comparsion, list, equation, sets, tree, etc.)
  geometrical action (perpendicular, tengency, concentric, etc.)
  transformational action (move, scale, rotate, array, etc.)

PARAMETRIC DESIGN EXERCISE

Parametric Machine

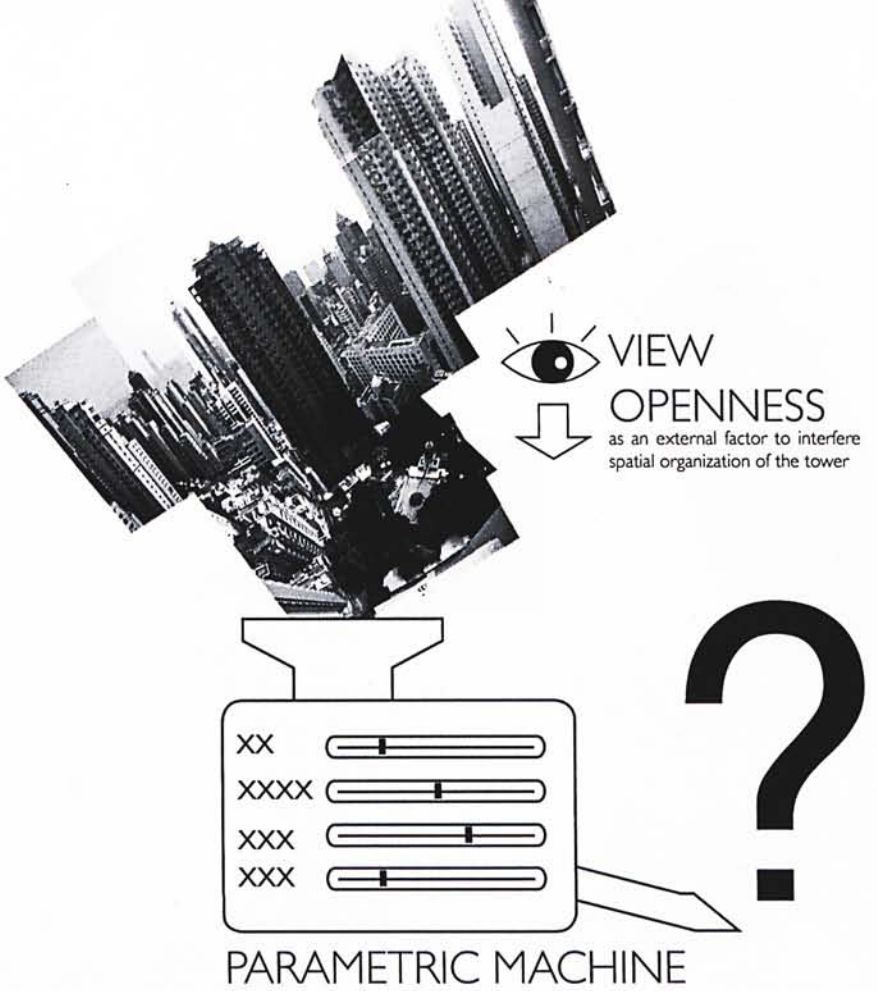
Parametric Mechanism
Interpretation into Design
GH scriptin process

\\Objectives
Parametric Design =
Designing Parameters

Parametric Machine

The Parametric Design Exercise explores "how to design parameters" for a wide range of interpretations of the "view openness" data graph and to see how that can influence the complexity of spatial organization.

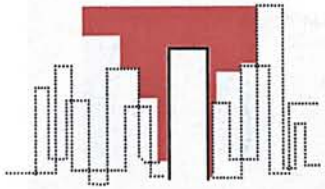
The exercise is base on an existing residential single tower in Central as an abstract context for experiment. Since it is more about building scale, the tested parametric variations happen on the internal differentiation (microscopic level) more than inter-buildings relation (macroscopic level). Chain/sequential effect is found as one of the key parametric strength to form linkage and relationship between the internal variations which may allow unexpected complexity of spatial organization emerged out through the process. Because of that, it is realized that parametric technique can be better suit for scenario with a demand for more interactions and intricate relatonships among variety of spaces. Otherwise, the parametric variations generated do not necessarily contribute to the organization and quality of space.

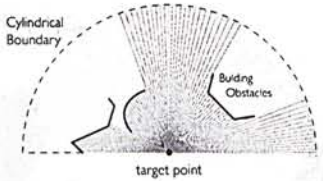


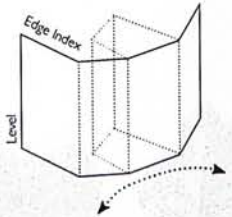
Parametric Mechanism

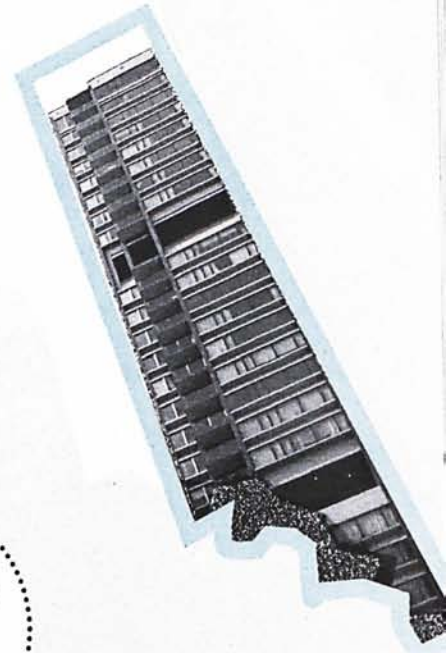
Soho 38

- a single tower residential project situated in Central along the pedestrian escalator









Step 1 Clarify
+ building mass
+ unit types

Step 2 Identify
+ site conditions

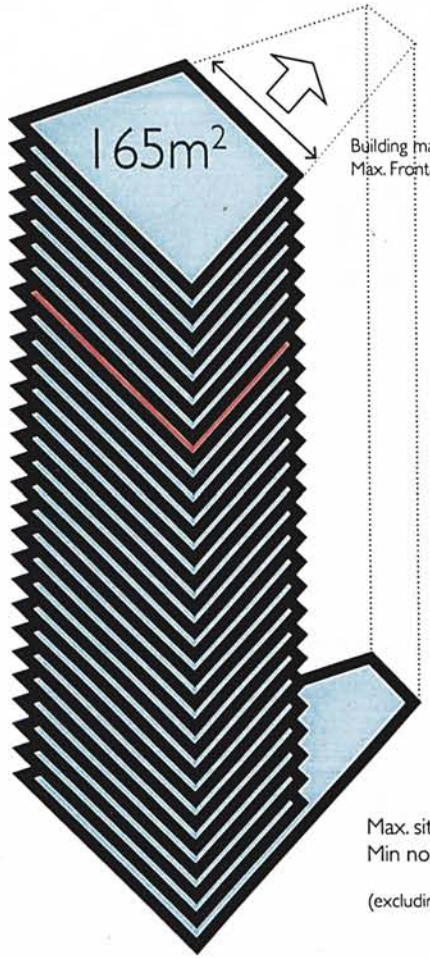
Step 3 Map
+ site value
+ resolution

Step 4 Deform
+ envelope

Step 5 Interpret
+ Colourization
+ Total Sum of Value
+ Median Value

Class of site	C
Site Area	410.5 m²
Permitted Domestic P.R	10
Permitted Domestic S.C.	40%

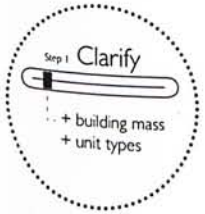
25 floors (max site coverage) +
(1) bonus floor + (1) skygarden

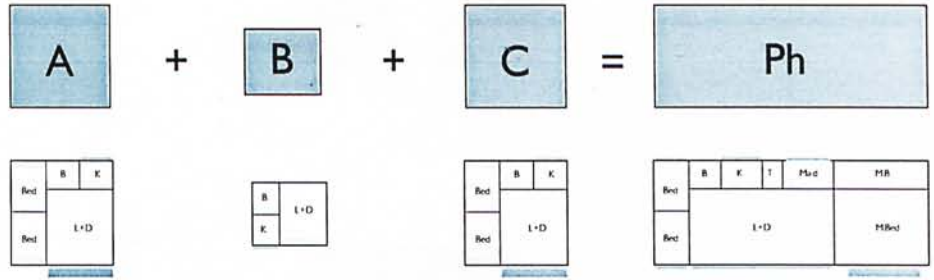


Building mass is pushed to obtain
Max. Frontage toward Victoria Harbour

Max. site coverage = 410.5 m² X 40% = 164.2 m²
Min no. of floors = 25

(excluding - core, balcony area)





25
unit A: 708 sq ft = 65.77sqm

Living + Dining + balcony 1
Kitchen 1
Bathroom 1
Bedrooms 2

M

25
unit B: 400 sq ft = 31.76 sqm

Living + Dining 1
Kitchen (open) 1
Bathroom 1

S

25
unit C: 690 sq ft = 64.10 sqm

Living + Dining + balcony 1
Kitchen 1
Bathroom 1
Bedrooms 2

M

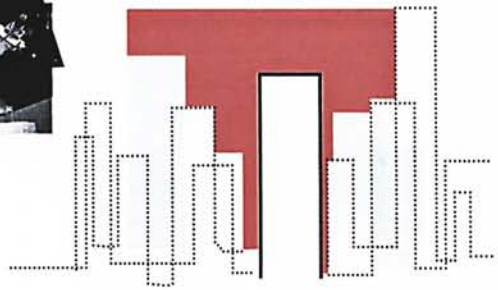
1
simplex: 1840 sq ft = 170.936sqm

Living + Dining 1
Master Bedroom + Balcony 1
Master Bathroom 1
Kitchen 1
Bathroom 1
Bedrooms 2
Maid room 1
Toilet 1

L

75 apartments + (1) penthouse

3 types (L, M, S)

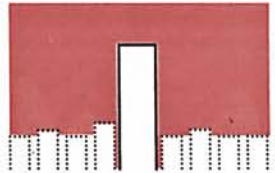


Scenario 1

in a hybrid dense urban area, surrounded by buildings of varied heights with topographical changes

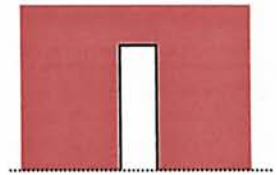
$$\text{Site Value} = \frac{\text{View Openness Percentage}}{\text{Noise Level}}$$

Other possible scenarios



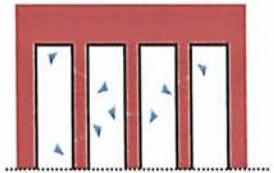
Scenario 2

in a rather monotonic urban area, surrounding context has subtle differences



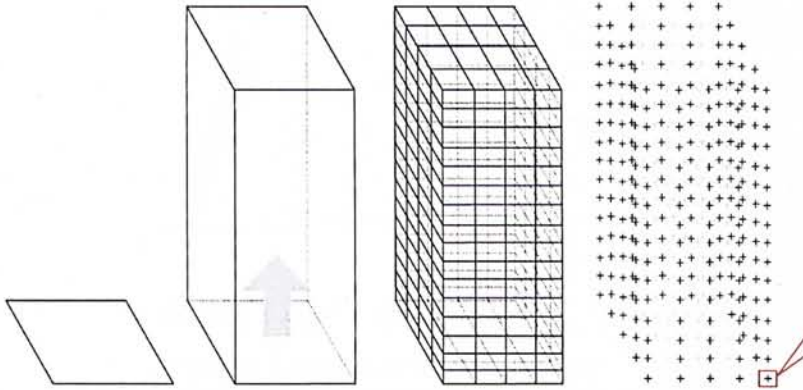
Scenario 3

a empty site with minimal site forces, driving forces to create variations with be more from the programme



Scenario 4

when it is a cluster of buildings, interaction will be formed among the buildings instead

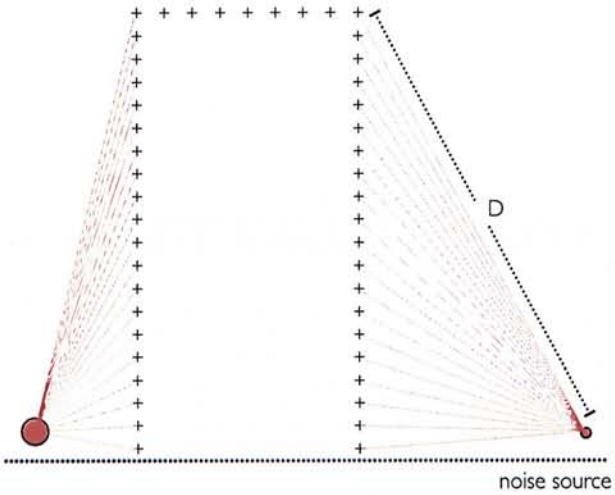


Plane as the site > Extrude as a volume > Subdivide the volume > Attach a grid of points on the surface

By parametric means, 2 values are aimed to obtain for Each Pt

+ Noise Level (1-10)

+ View Openness Percentage (1-100%)

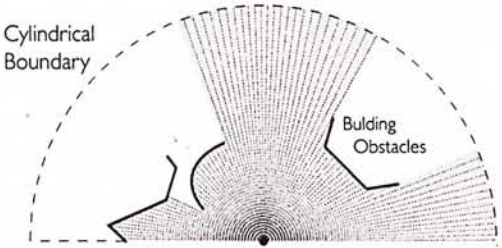


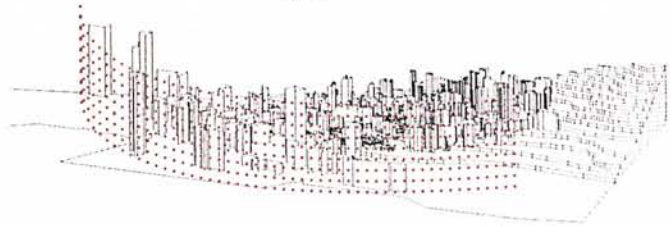
Noise Level (1-10)

= Distance from the major noise source (D) X
Amplitude of the noise source

Step 1 Locate the major noise sources around the site
Step 2 Measure amplitudes of the noise sources
Step 3 Calculate distance (D) between the noise source and target point
Step 4 Add up all the distances if more than one noise sources are found

Plan sections showing approximate result in 360°

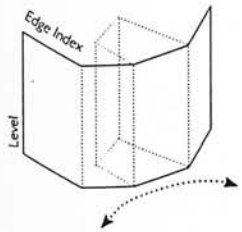


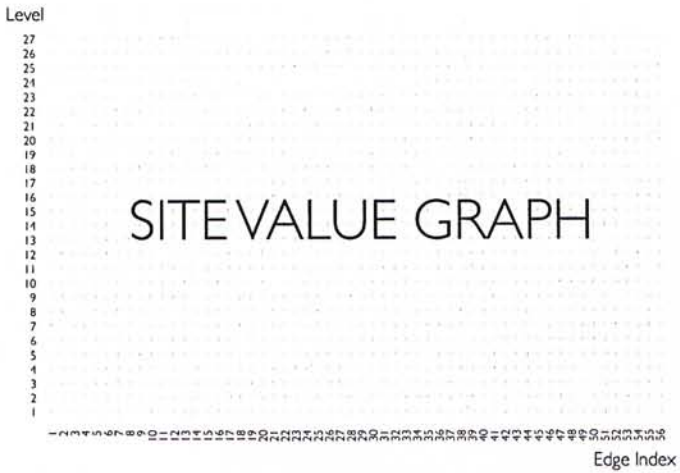


View Openness Percentage (1-100%)

$$= \frac{\text{Total Vision Distance with Obstacles}}{\text{Total Vision Distance without Obstacles}} \times 100\%$$

Step 1 Make a digital site model
Step 2 Define a circular cylindrical boundary
Step 3 Extend lines to the boundary wall evenly from the target point
Step 4 Get the total distance without obstacles (D_1)
Step 5 Get the total shortened vision distance with obstacles (D_2)
Step 6 View Openness Percentage = (D_1 / D_2) X 100%

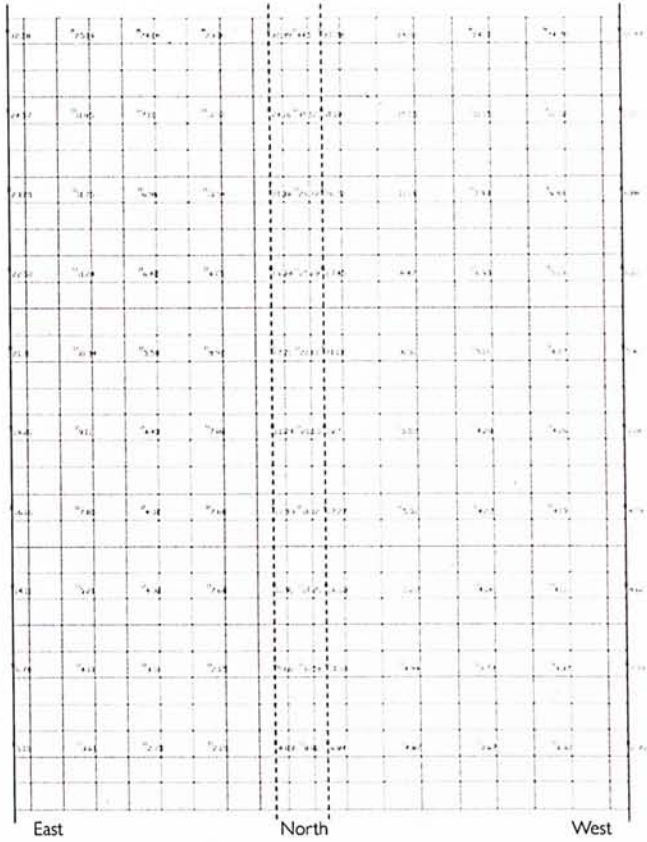




Unfolding the elevation of the building mass

Due to the limited time frame and specific site condition, the site mapping study only takes View Openness, a more significant factor, into consideration and composed into a SITE VALUE GRAPH.

The final View Openness Value Graph of 3 main volume facades



Step 5 Interpret

+ Colourization
+ Total Sum of Value
+ Median Value

Interpretation 3:
Total Sum of View Openness Index as Flat Mix Indicator

Extra (1L)

276.78

1L

160.16

2M+1S

133.65

119.43

108.1

1M+2S

94.77

33 X 6 = 297sqm

84.88

4S

77.85

33 X 6 = 297sqm

48.31

41.42

Carpark / Clubhouse

Entrance Lobby

32 30 27 24 21 18 15 12 9 6 3 0

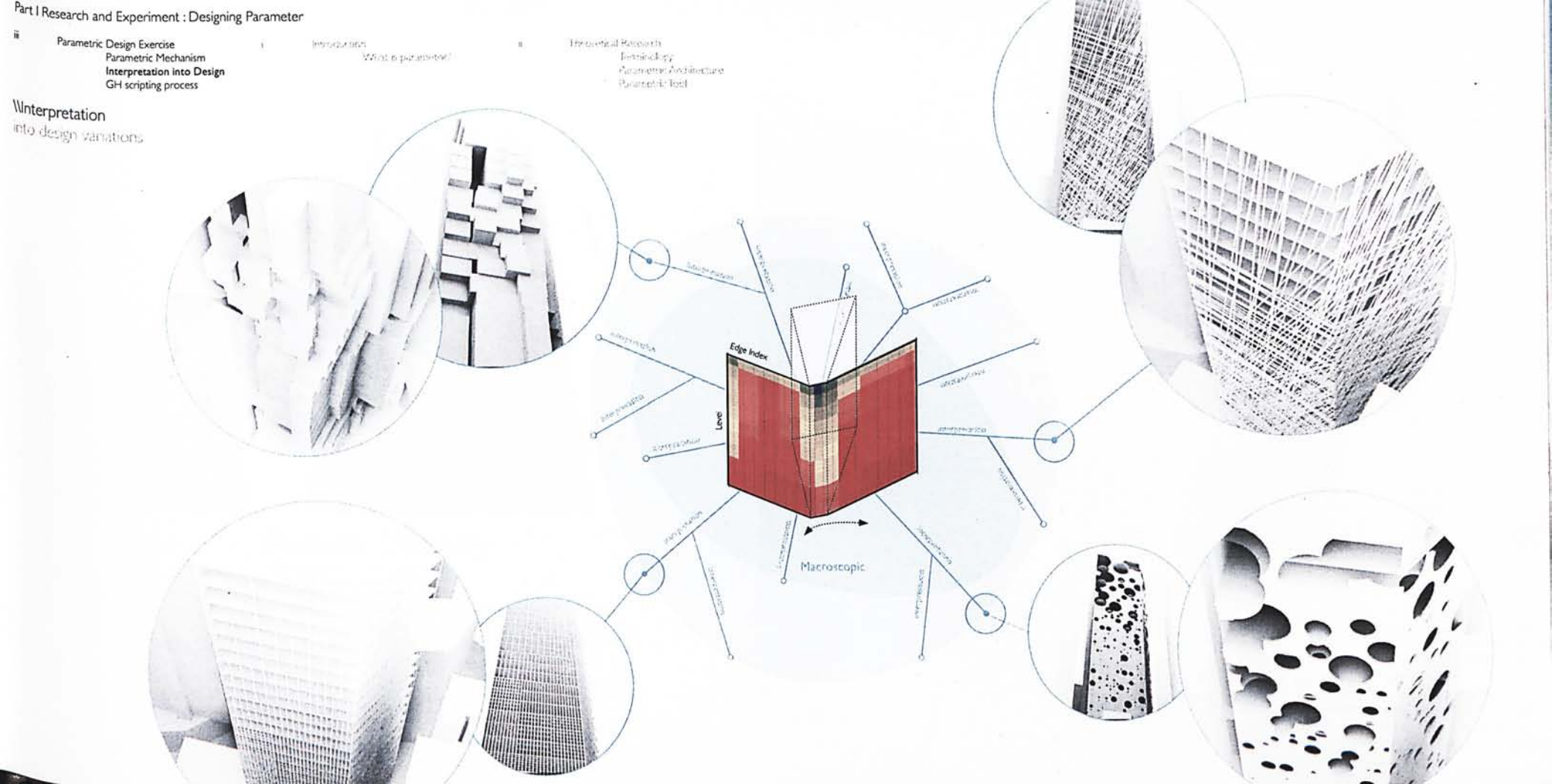
Total Sum of View Openness Index per floor

Interpretation 1: Colourization

Interpretation 2: Median Openness Percentage on West Facade

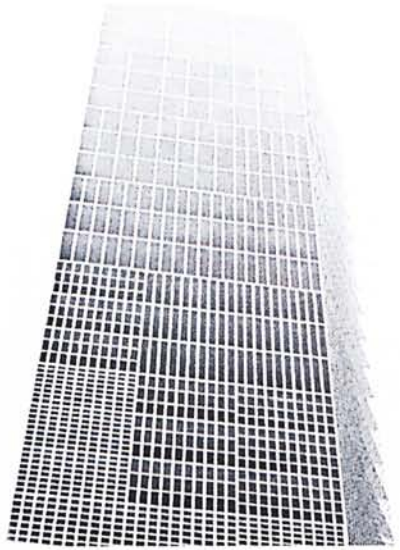
East North West

\\Interpretation
into design variations

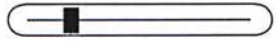


//Interpretation

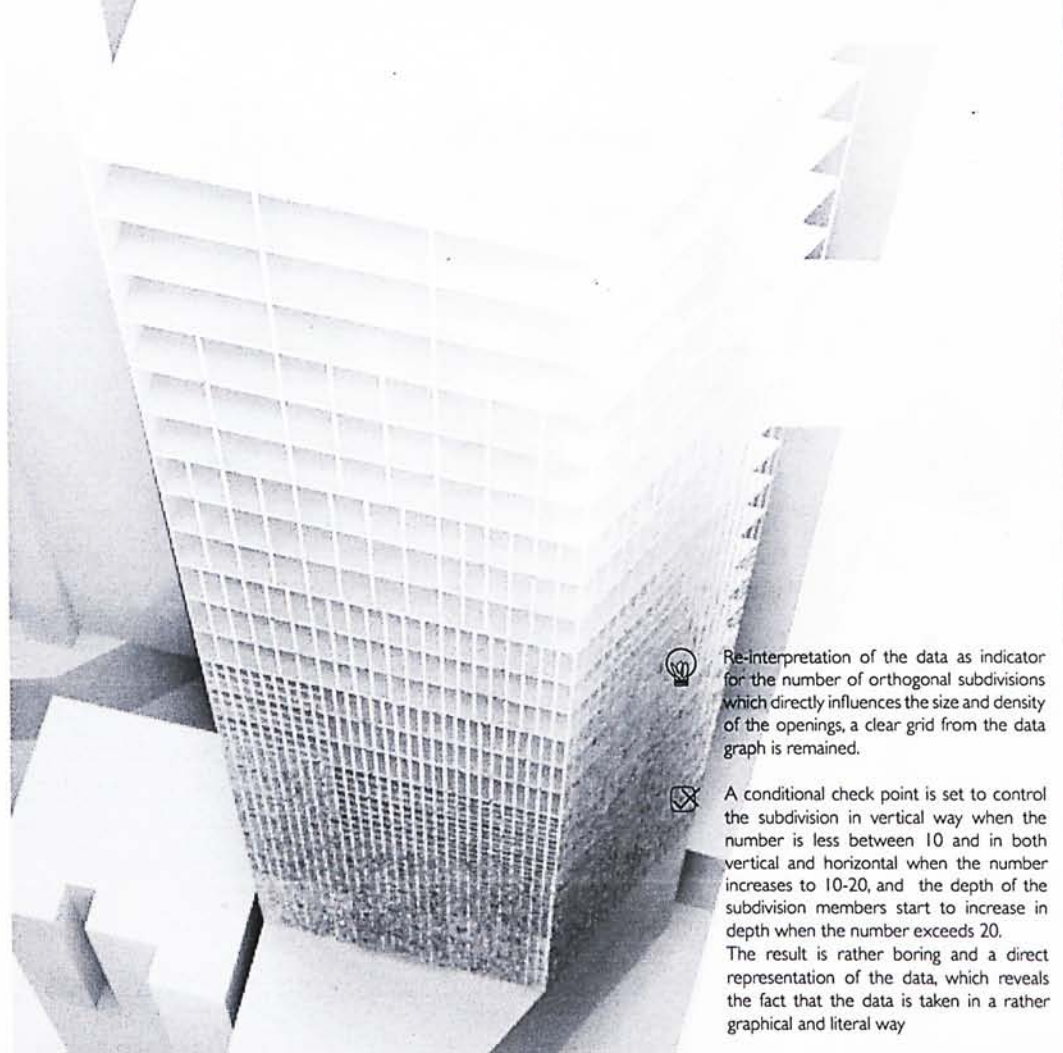
Variation I



Facade Density



+ number of vertical subdivision (data+conditional)
+ number of horizontal subdivision (data+conditional)
+ width of subdividion members (data+ formula)
+ depth of subdivision members (data+formula)



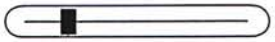
Re-interpretation of the data as indicator for the number of orthogonal subdivisions which directly influences the size and density of the openings, a clear grid from the data graph is remained.

A conditional check point is set to control the subdivision in vertical way when the number is less between 10 and in both vertical and horizontal when the number increases to 10-20, and the depth of the subdivision members start to increase in depth when the number exceeds 20.
The result is rather boring and a direct representation of the data, which reveals the fact that the data is taken in a rather graphical and literal way

Interpretation

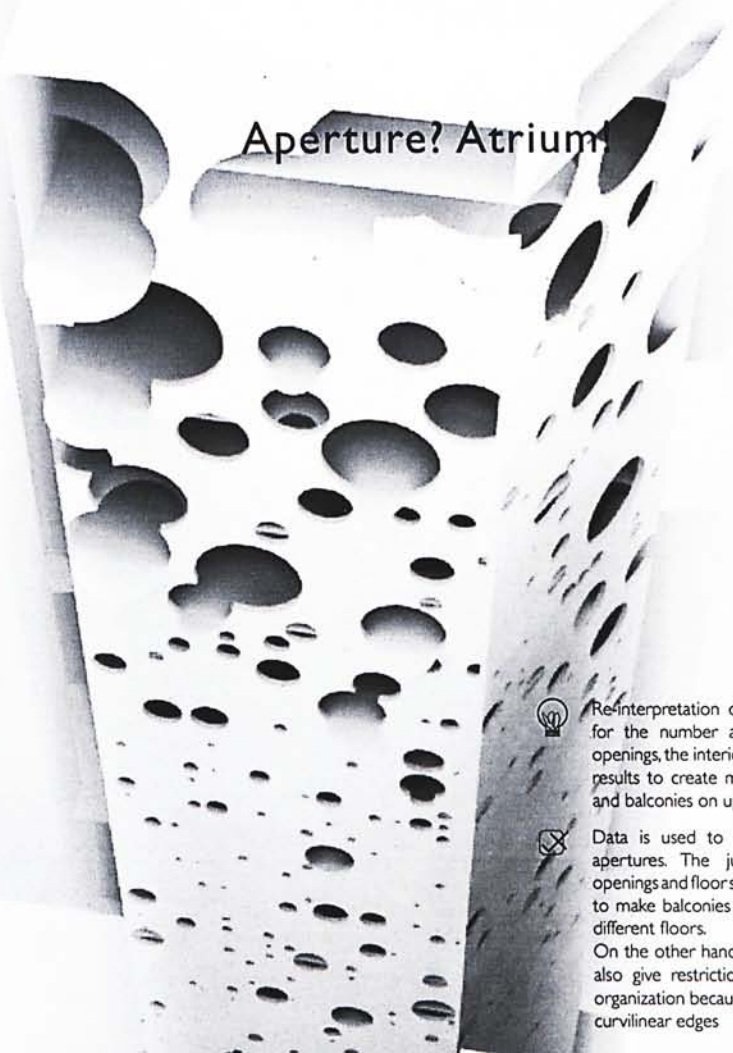
Variation 2

Random Aperture



+ number of openings (data)
+ diameter of openings (data + formula)
+ position of openings (data + random)
+ depth of openings (date+ formula)
+ floor slab reaction to openings (design interpretation)

Aperture? Atrium!



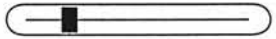
Re-interpretation of the data as indicator for the number and the size of facade openings, the interior is then adapted to the results to create more and bigger atriums and balconies on upper floors

Data is used to create random circular apertures. The junctions between the openings and floor slabs create opportunities to make balconies and atriums to connect different floors.
On the other hand, one could say, this may also give restriction to the interal spatial organization because of its randomness and curvilinear edges

Interpretation

Variation 2

Randomized and Distorted Density



+ number of cross intersections (data)
+ position of cross intersections (data+random)
+ rotational angle (0 - 45 degree)
+ width of members (design interpretation)
+ depth of members (design interpretation)

Mullion? Structure!

Re-interpreting the data as indicator for the number and the rotational angles of cross intersections which is overlayed to create changing desnity.

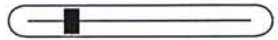
The data is being interpreted in a way that chain reaction happens to the number of cross intersection and its rotation angle, so that the facade is perceived more as a whole

The pattern can be further interpreted as part of the structure for the building and with depth which can influence more the internal spatial organization.

Interpretation

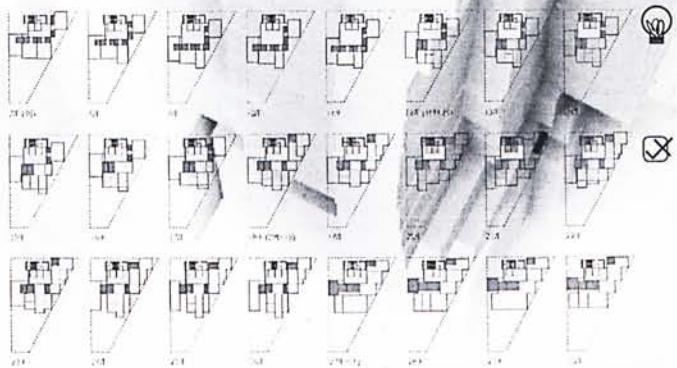
Variation 4

Flat Mix



+ type of flat combination (total sum of openness %)
+ location of living room (median curve)
+ depth of the service zone
+ depth of the living zone

Volumetric diagram!?



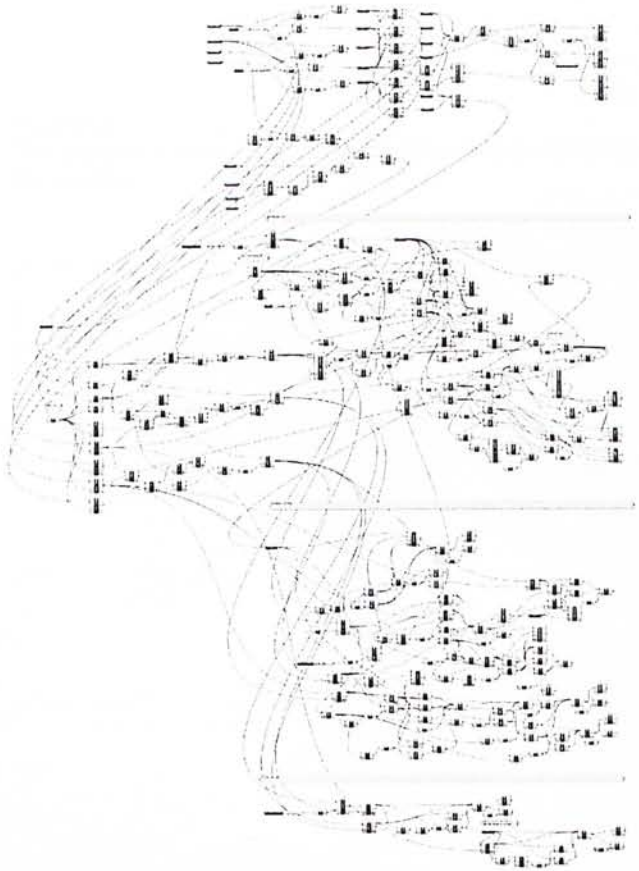
Base on the flat mix indicator and the median openness percentage curve, the proportion of each flat is configurated to obtain a balance between pragmatic requirement on the floor area and view quality.

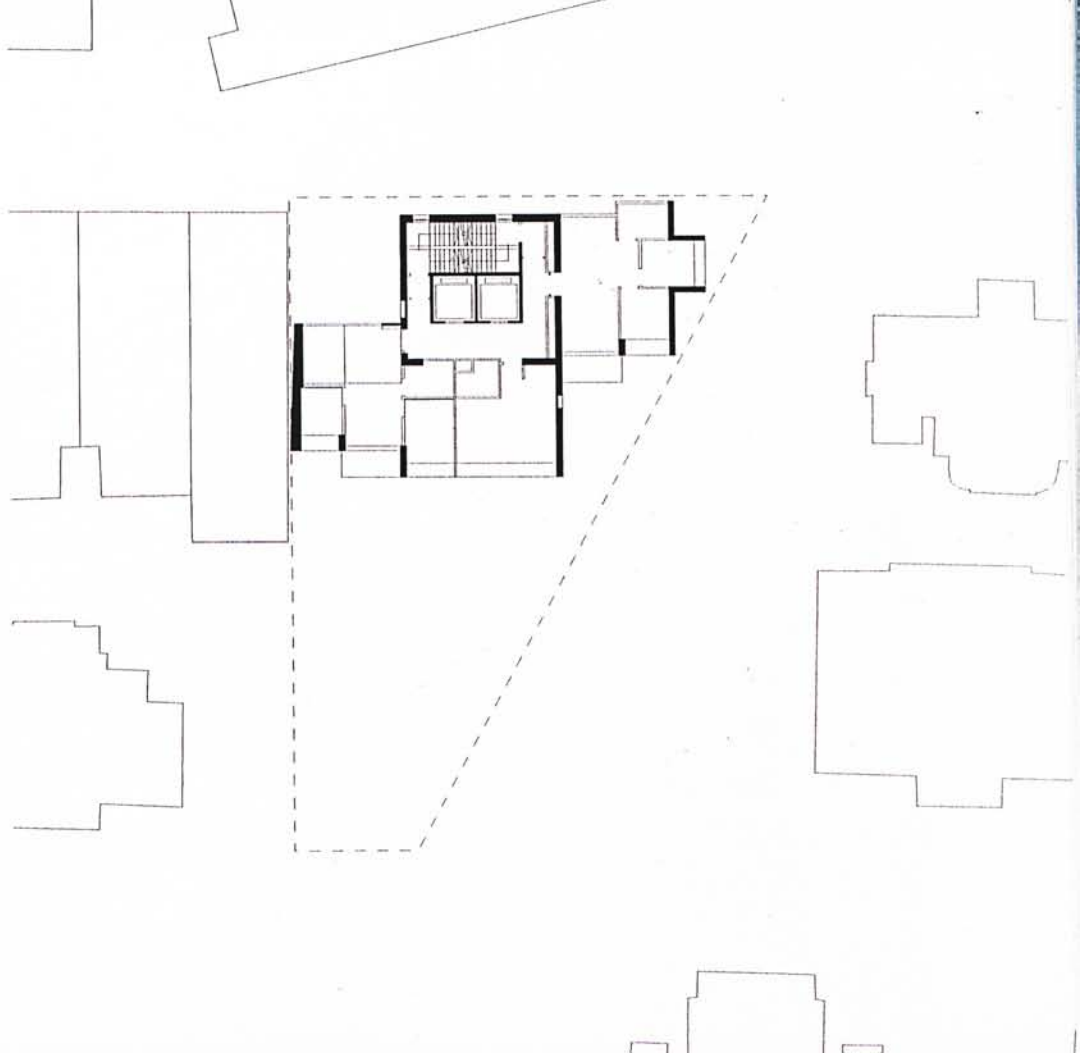
The result is purely a volmetric diagram which aims to parametrize the spatial organization under the influence of view openness, but it is not implying a new spatial organization. Floor segregation is remained. Chain reaction between floors is lacking here which makes the oscillating floor footprints arbitaray or meaningless. Further interpretations of the volume into architectural elements are needed.

\\GH scripting process -

Variation 4 (Flat Mix)

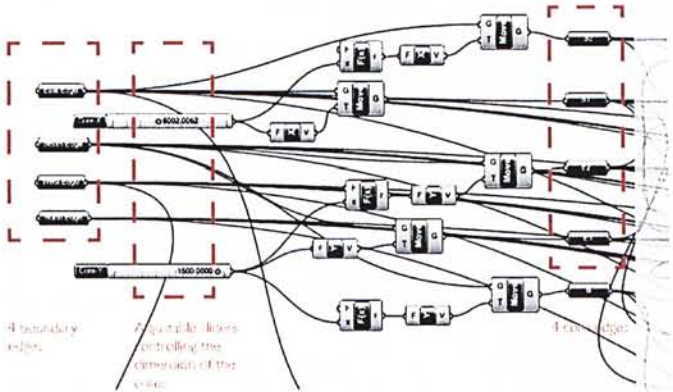
Example : Given the Original Plan of 2 Medium + 1 Small unit distribution, according to the view openness index, it is to be changed to 1 Medium + 2 Small unit distribution

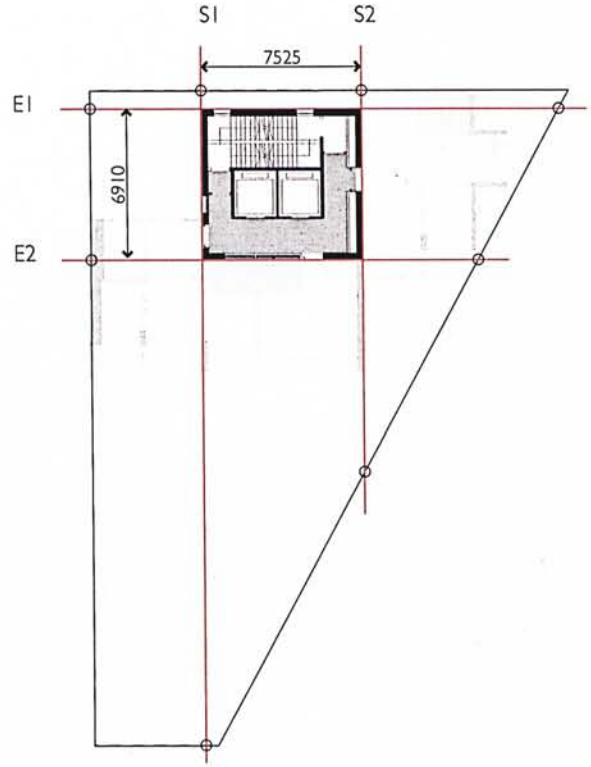




\\GH scripting process -
Variation 4 (Flat Mix) Step 1

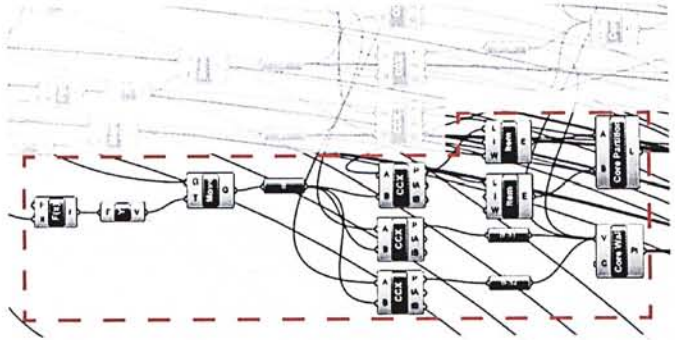
Assumption -
The original core is taken as reference. Fix it in a dynamic relationship with the boundary

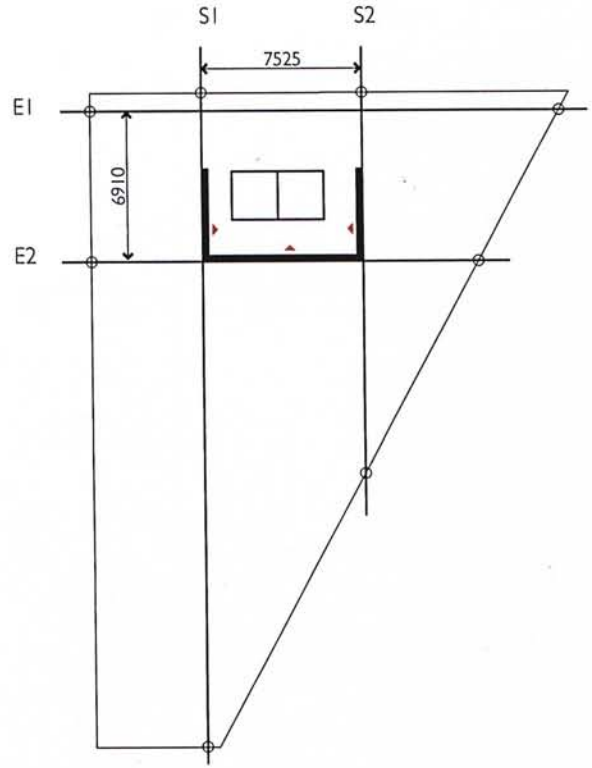




\\GH scripting process -
Variation 4 (Flat Mix) Step 2

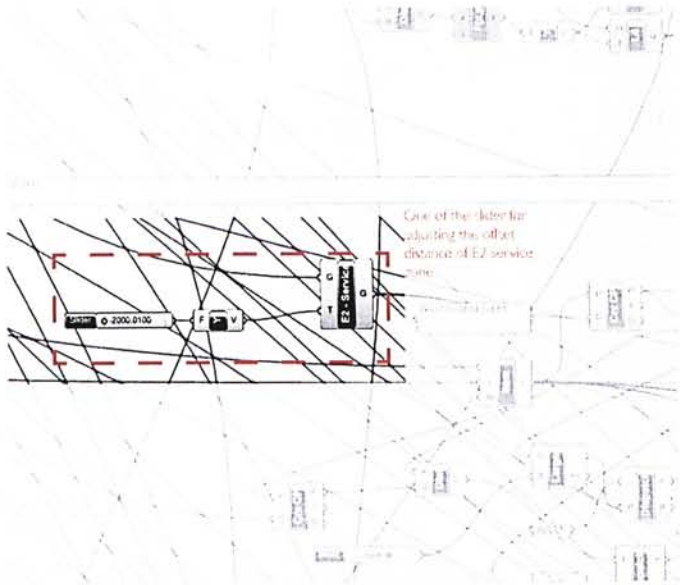
Abstract the core as a access /connection points; Identify the access length between core and apartment units

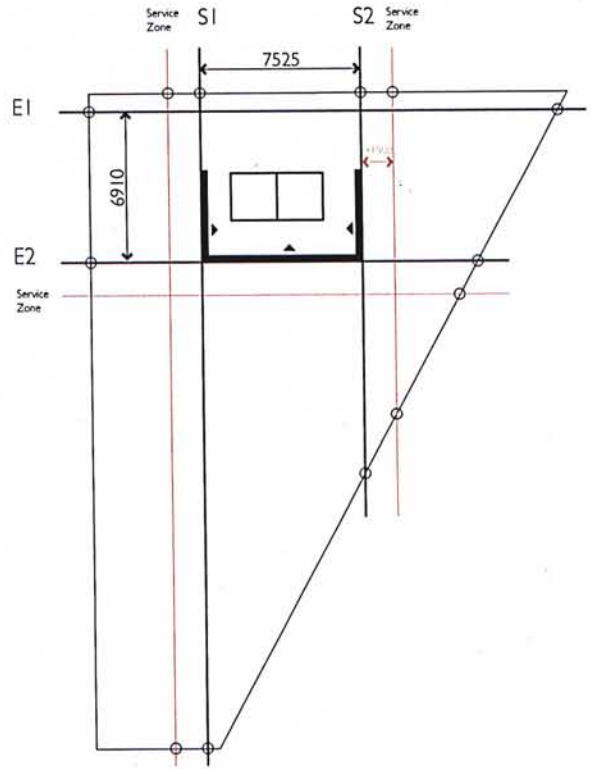




\\GH scripting process -
Variation 4 (Flat Mix) Step 3

Offset from the core minimium 1.5m as service zone

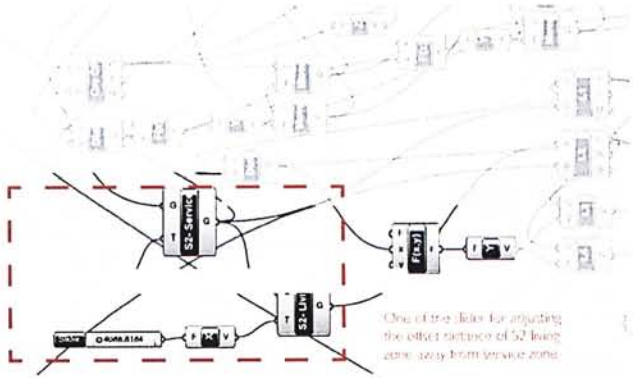


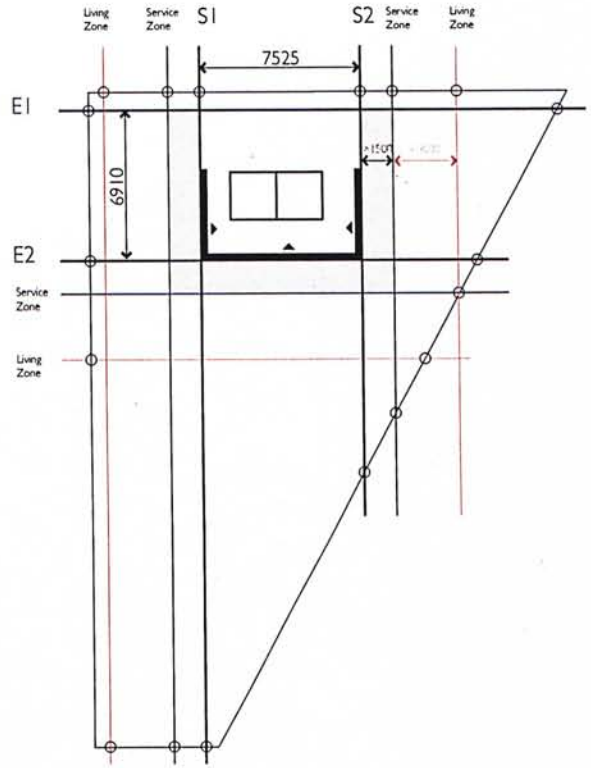


\\GH scripting process -

Variation 4 (Flat Mix) Step 4

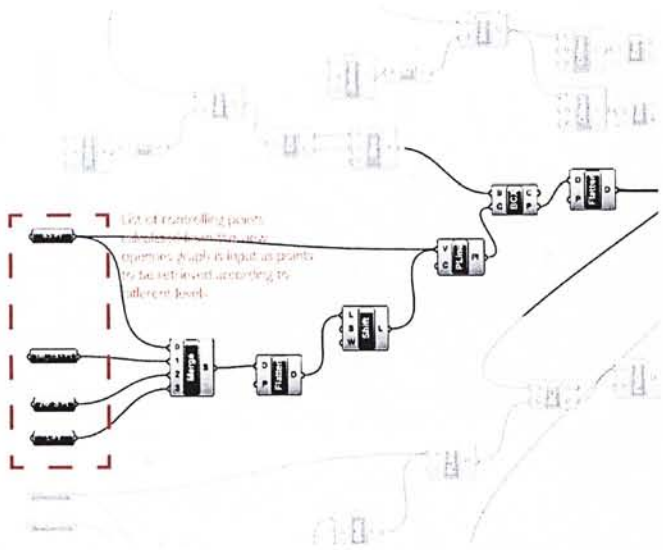
Offset from the service zone minimum 3m as living zone

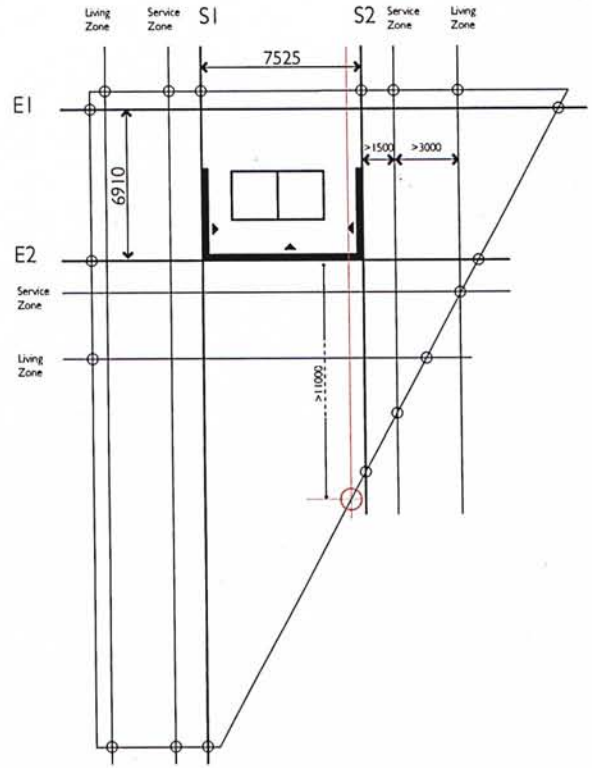




\\GH scripting process -
Variation 4 (Flat Mix) Step 5

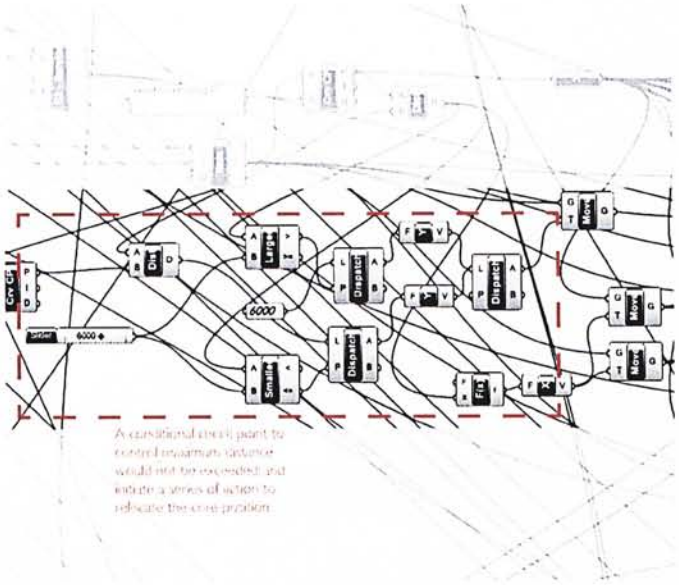
According to the view openness graph, the mean point is set along the west edge; line is extended out to measure the distance from the core. If the distance is bigger than 11m for Medium unit (6m for Small unit), the core will be shifted forward to reduce the length. If the distance is too small, the core will be shifted backward.



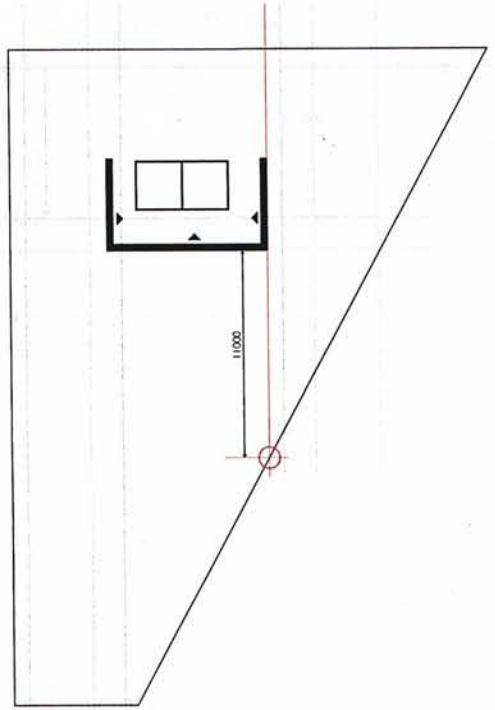


\\GH scripting process -
Variation 4 (Flat Mix) Step 6

Core is adjusted to a new position

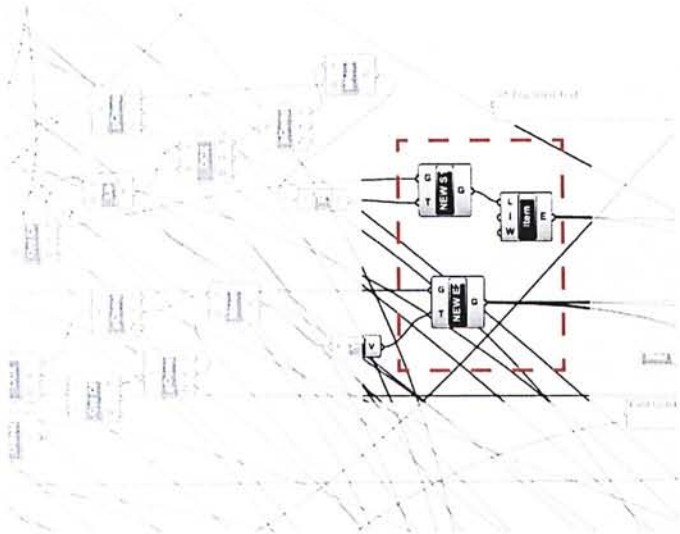


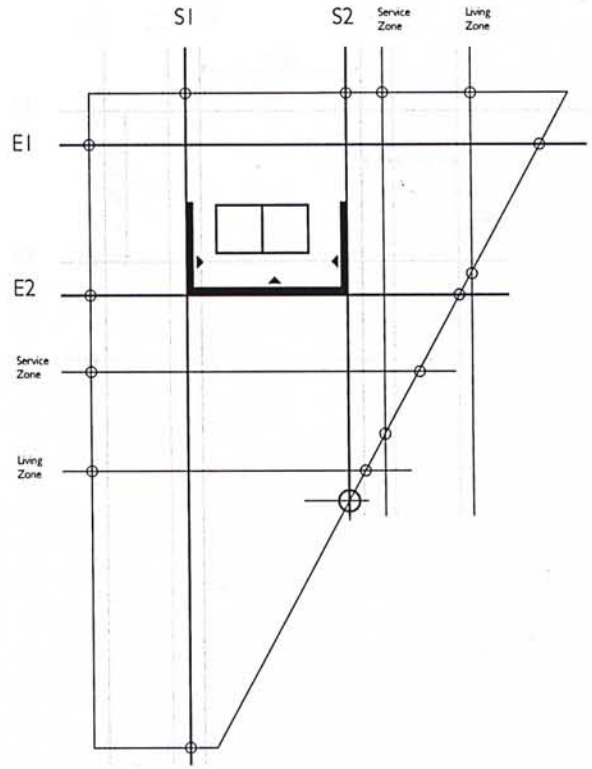
A conditional check point to control maximum distance would not be exceeded and initiate a series of action to relocate the core position



\\GH scripting process -
Variation 4 (Flat Mix) Step 7

New offset lines are defined; and the four edges are redefined again



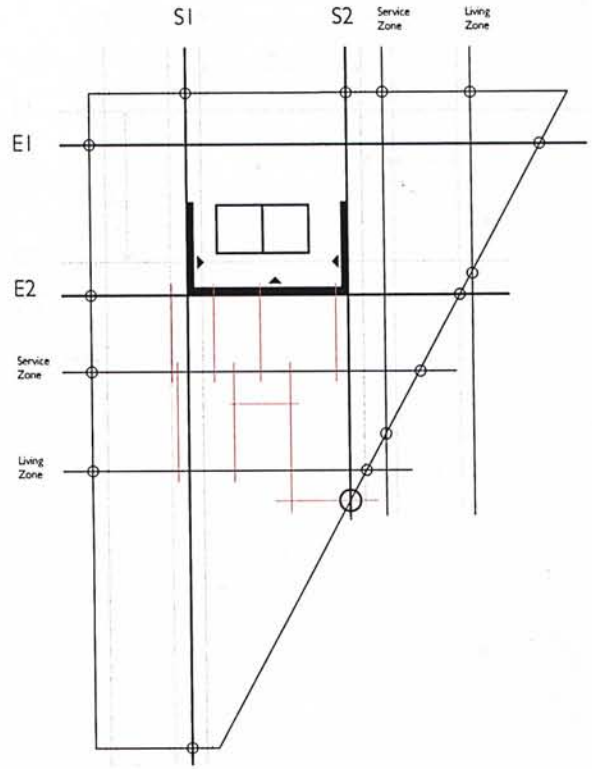


\\GH scripting process -
Variation 4 (Flat Mix) Step 8

By identifyig pre-set area for each type of rooms, subdivision of space starts from the apartment in the middle; and then extend to the other two

For M unit
+ Living 14sqm
+ Dining 11sqm
+ Bedroom1 8sqm
+ Bedroom2 12sqm
+ Kitchen 9sqm
+ Bathroom 7sqm

Total area 66 sqm

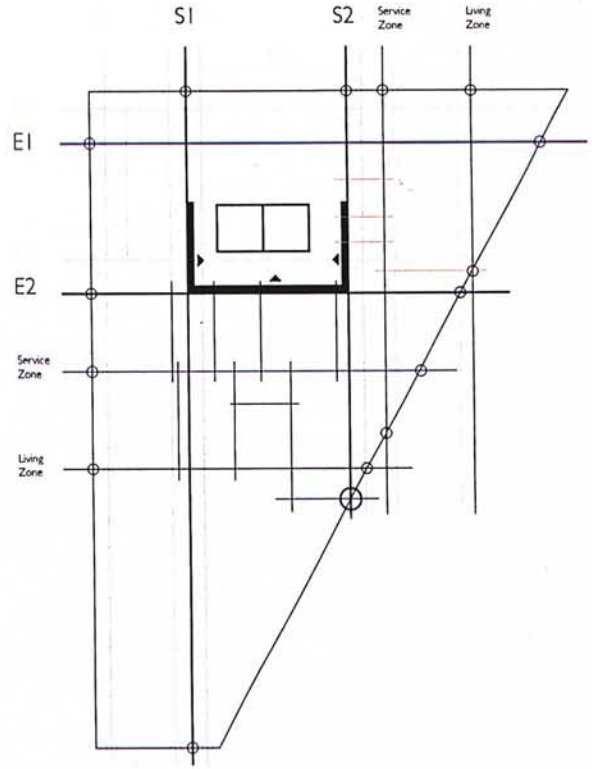


\\GH scripting process -
Variation 4 (Flat Mix) Step 9

For the Small unit type on the west and the east sides, the division of space is rather simple. Only a single living space is required.

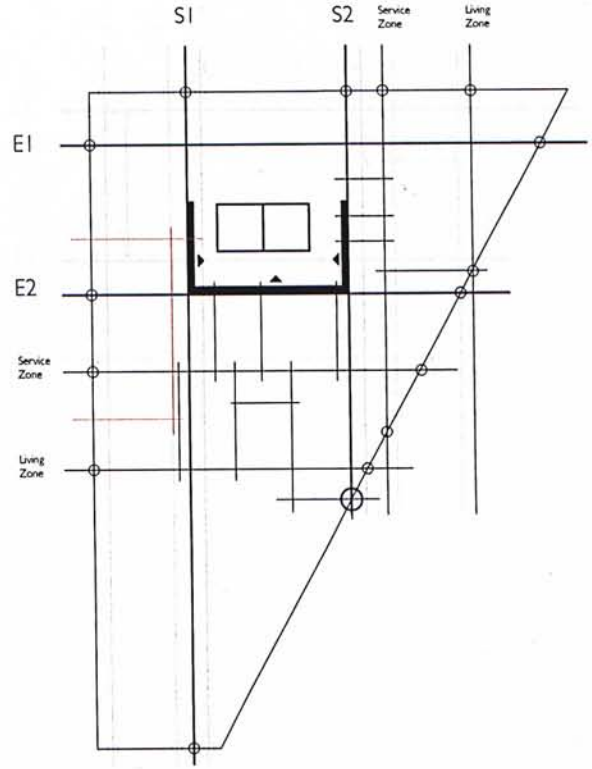
For S unit
+ Living 24sqm
+ Kitchen 3sqm
+ Bathroom 4sqm
+ Entrance 2sqm

Total area 33 sqm



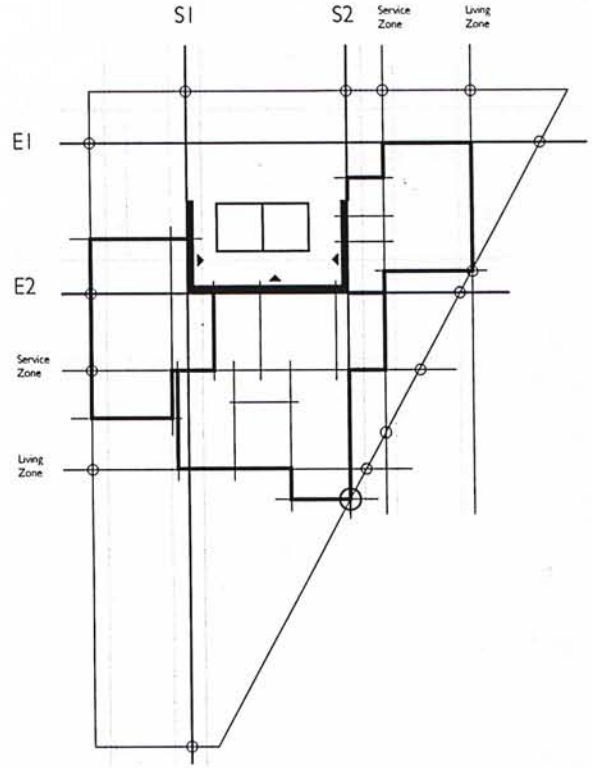
\\GH scripting process -
Variation 4 (Flat Mix) Step 10

The last unit on the east side



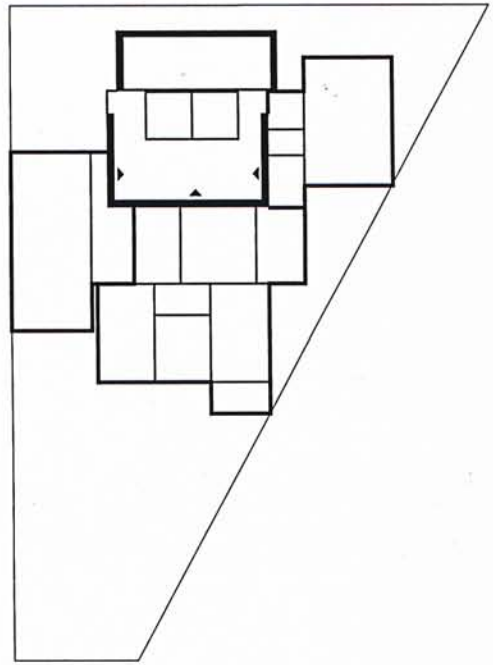
\\GH scripting process -
Variation 4 (Flat Mix) Step 11

Profile lines of the 3 apartment units



\\GH scripting process -
Variation 4 (Flat Mix) Step 12

When every floor is fixed, the position of the lift shaft and fire escape stair are re-located to ensure no overlapping of space.



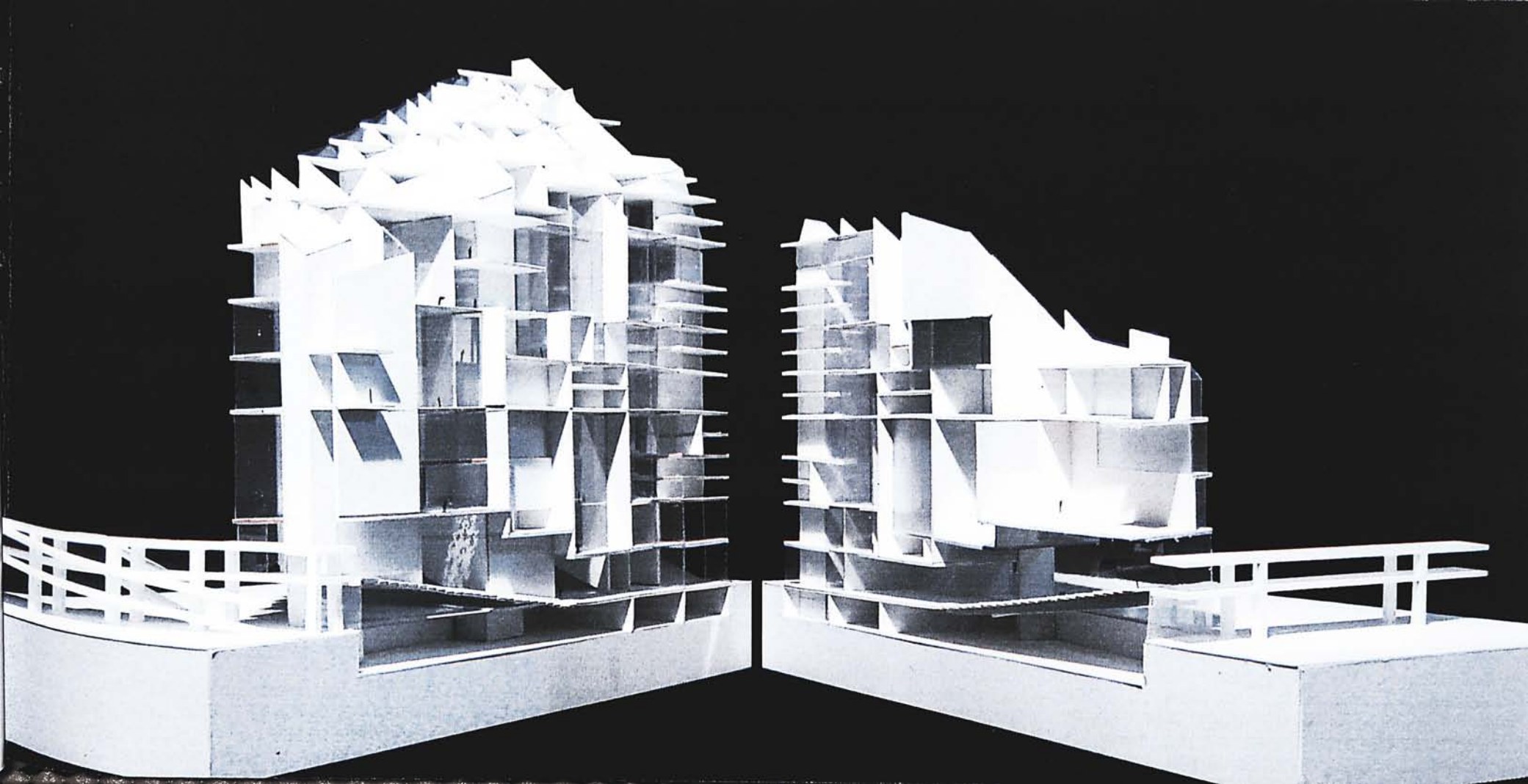
Part III

architectural project . parametric house

School of Architecture . The Chinese University of Hong Kong . Thesis Report . WONG Chui-kwan Alice . 2009 - 2010

Parametric Variation in Architecture

from Designing Parameter to Parametric Design



ARCHITECTURAL PROJECT

Parametric House

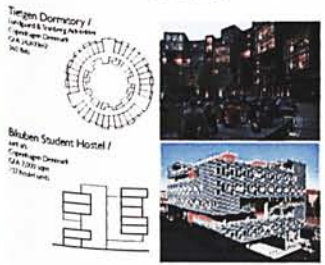
Early Development
Drawings
Photos
Spatial Sequence

\\Objectives

Designing Parameters =
Parametric Design

\\Precedent

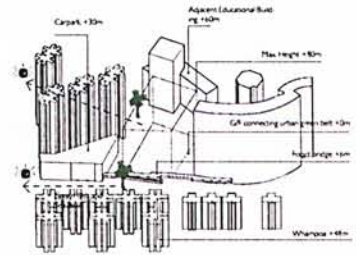
Student Hall of Residence



Parametric House

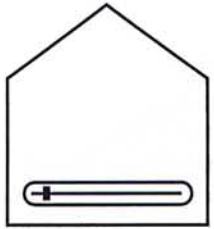
As a continuation of the parametric design exercise, the architectural project would like to take a step further to aim for a "parametric design" with complexity of spatial organization. Thus, parametric variations can contribute to the spatial relationship rather than simply expressed in architectural elements. Parametric is not treated just as a formal tool to create exciting form, but is taken for its strength - "chain relation" to correlate different spatial parameters for complexity of spatial organization of in-between public & private space.

A specific program - Student Hall of Residence, and a specific site in Hung Hom are chosen to create a scenario which has a demand for more interactions and intricate relationships among variety of spaces. Moving on from dealing with the issue about external view openness, the focus of this time will be tackling the dilema between the internal in-between space as something "to-be-seen" for social interaction among students and private space as something "not-to-be-seen" for personal solitude.



location map HUNG HOM 0 50 100 250m

\\Conceptual Diagrams
Spatial Variation



+ size dimensions (width/length/height)
+ openings (position/dimensions)
+ connection condition
+ orientation angle
+ distance from another same component
+ number of cross intersections
+ ……

I call it "Parametric House", a house formulated by a description of dynamic process of a set of spatial parameters to create a wide range of connected and differentiated spaces.

Viusal connections of different communal spaces

No segregation
of floors

Complexity
= use less but achieve more

No definite boundary between circulation space and internal space

Building up chain spatial relationships between variety of spaces

Macro X Micro Variation

No centre/axes
or focal points

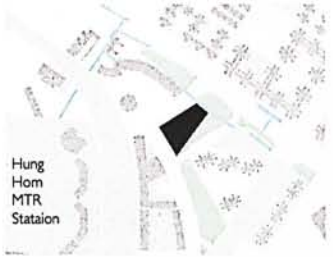
Building mass is not seen as repetitive packing of rooms

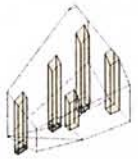
Casual encounter

Free/diverse movements

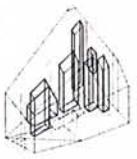
Non-hierarchical
form of grouping

Site area 5800 sqm
Plot ratio 8.6
GFA 50,400sqm
Height limit 80 pdm
Site coverage 40%
Accommodation 3000 students



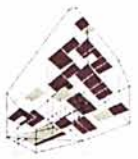


Vertical Cores
for direct acess to different floors



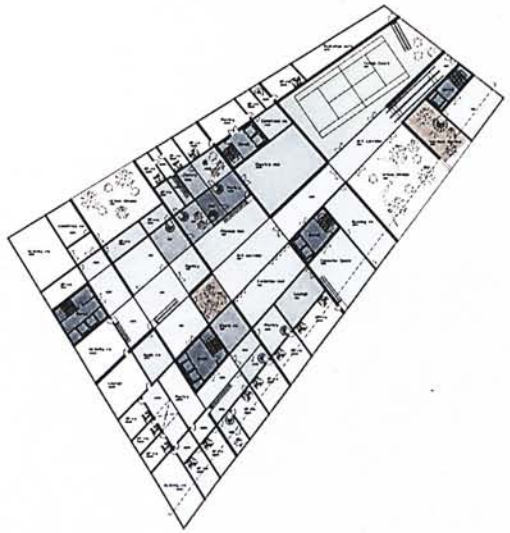
Voids
as walkable lightwell with perforated floor panels

Major Paths
for informal encountering around the whole building

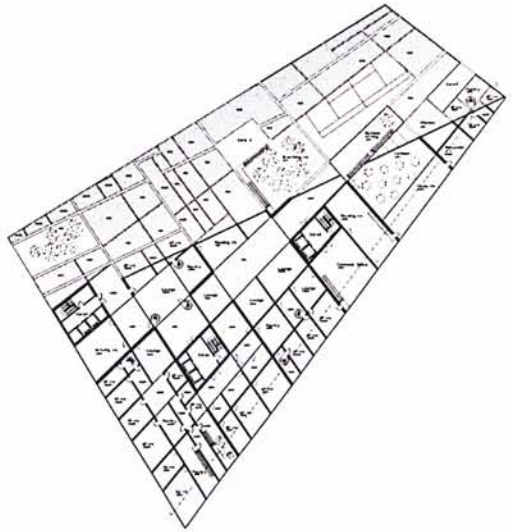


Major Programmes
for gathering, common activties

plan +0.0 / +6.25

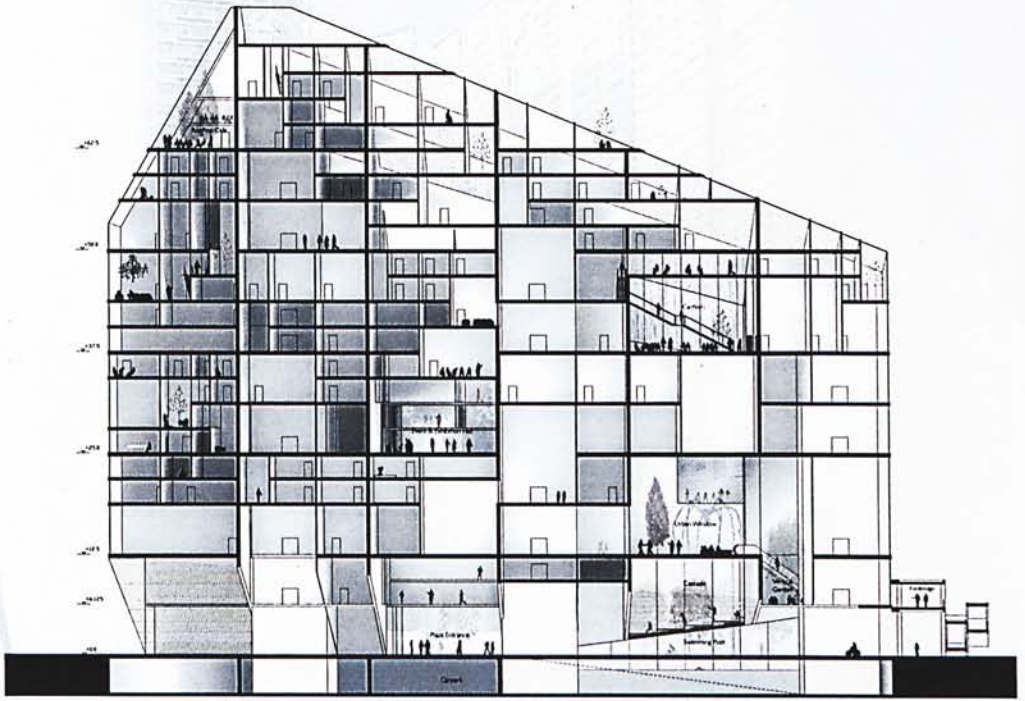


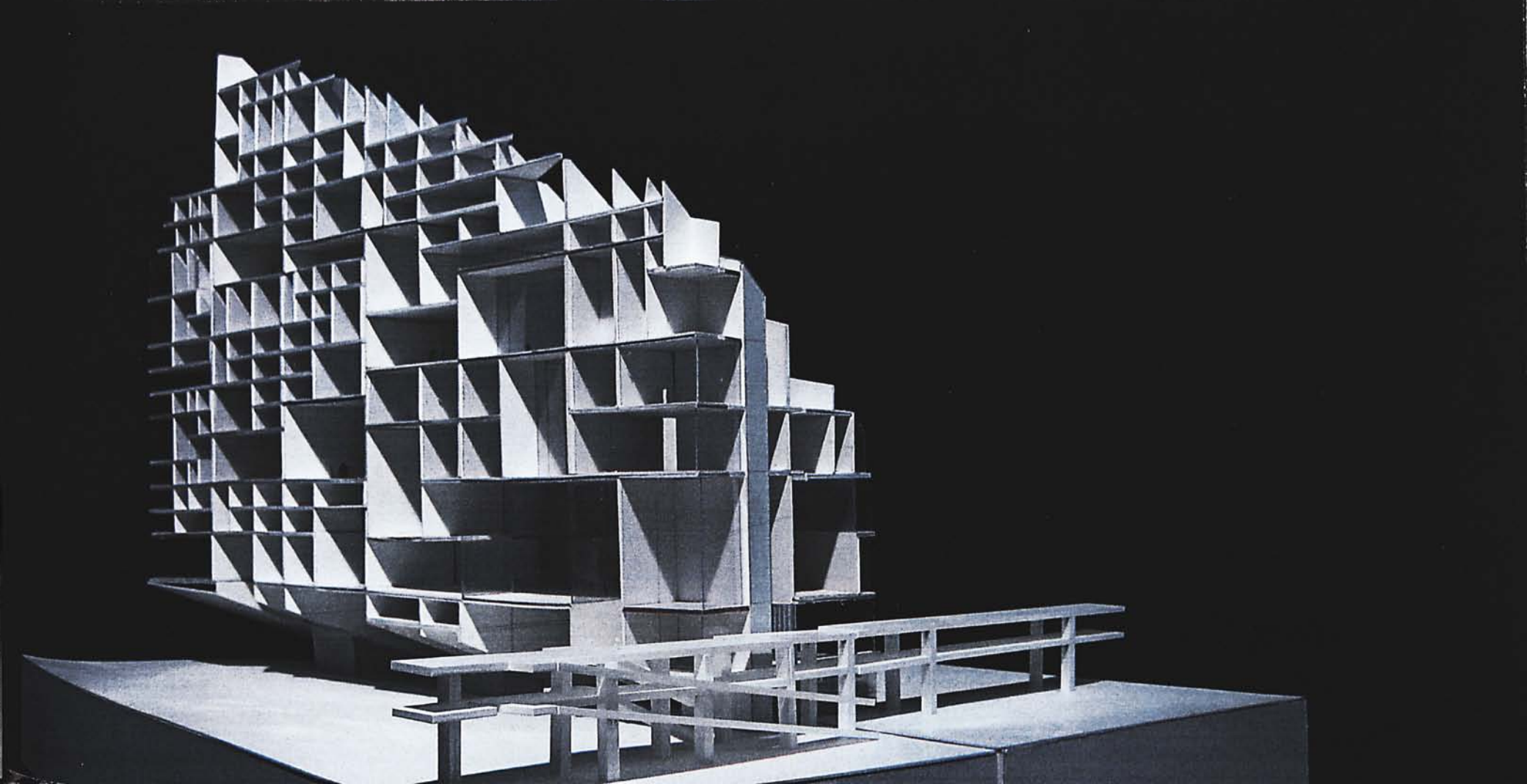
plan +46.875

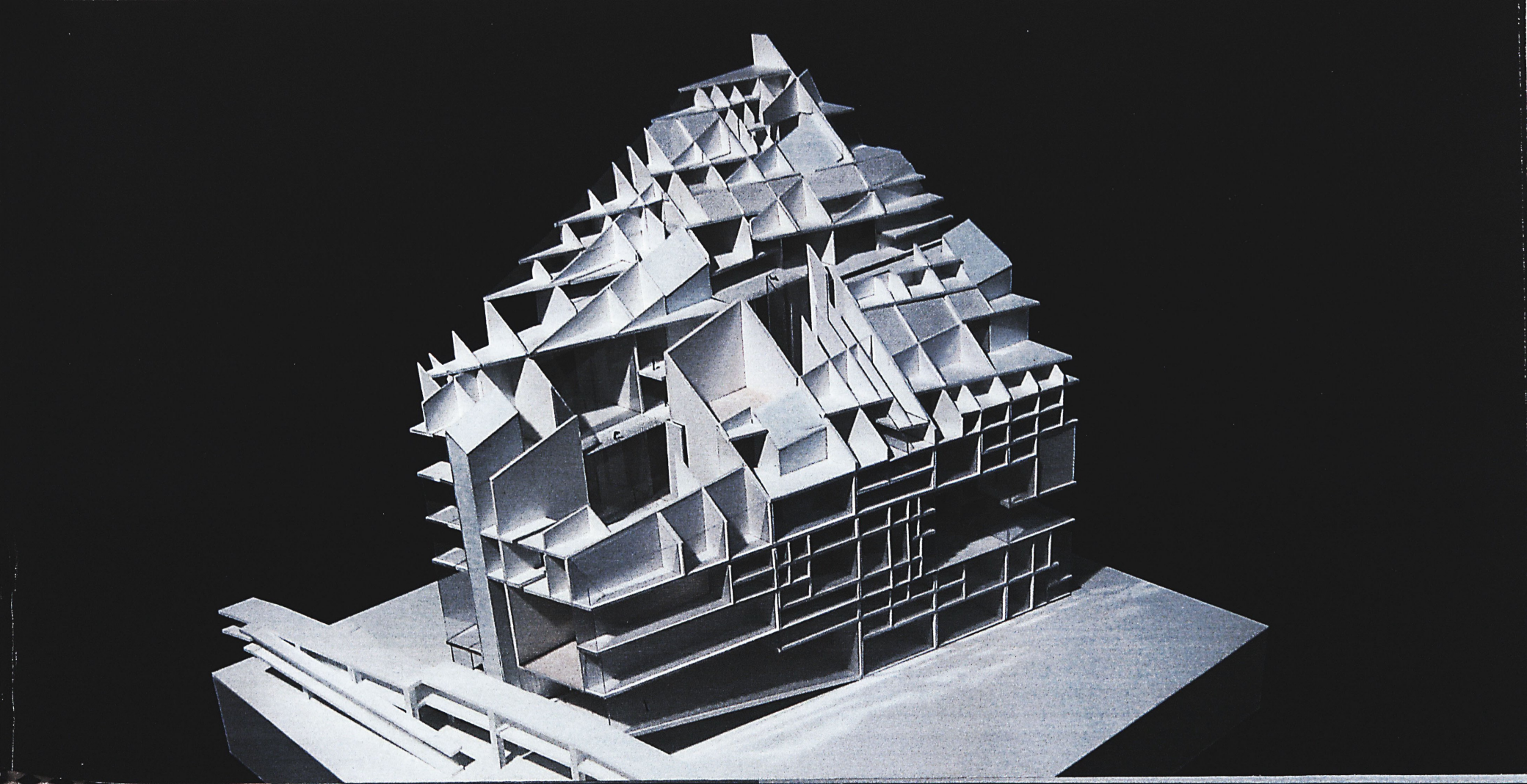


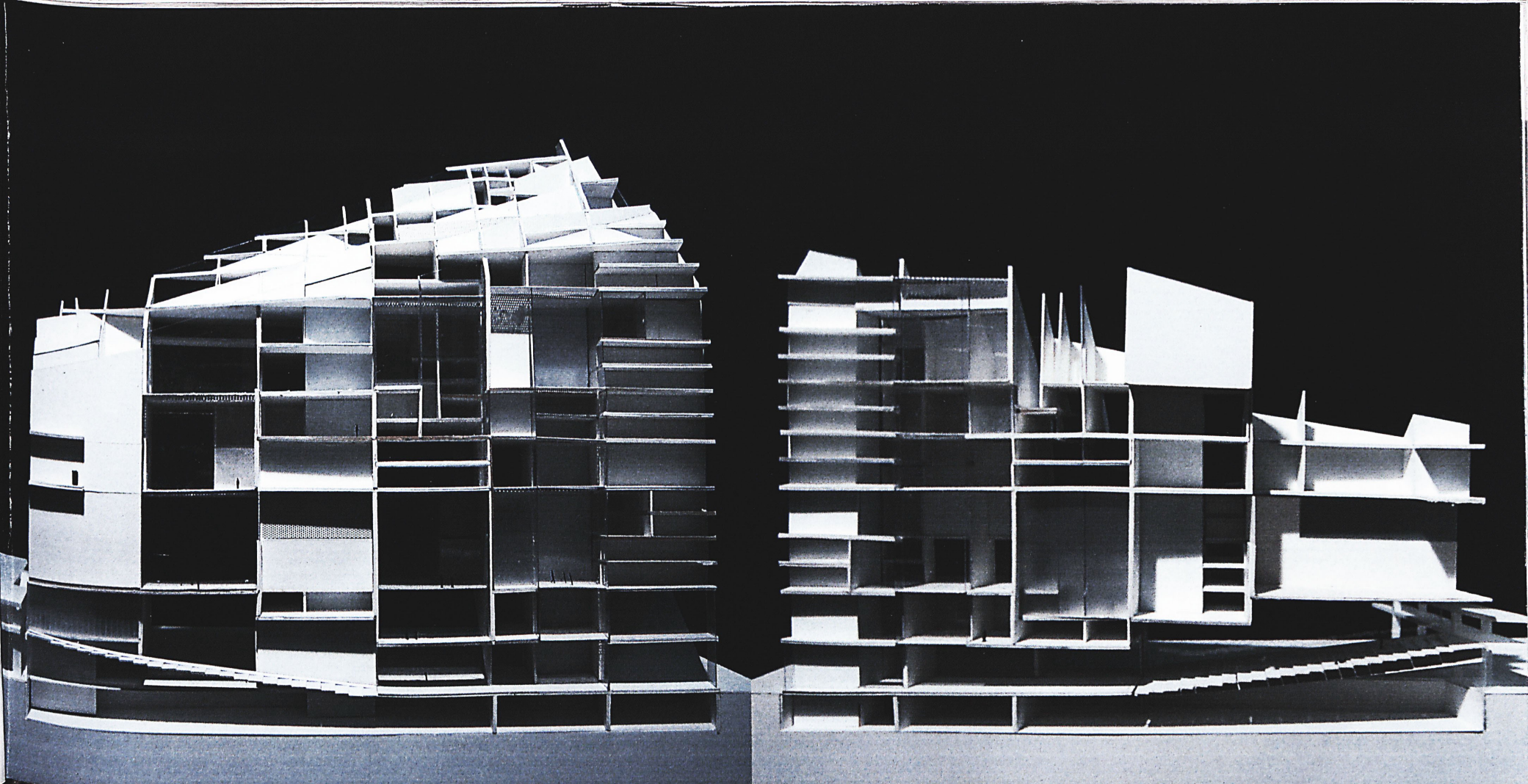
plan +21.875

\\Abstract Subdivision Model







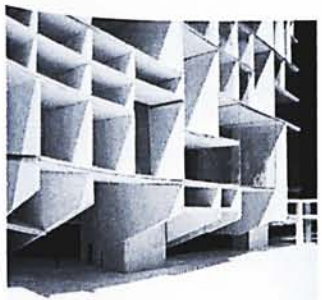


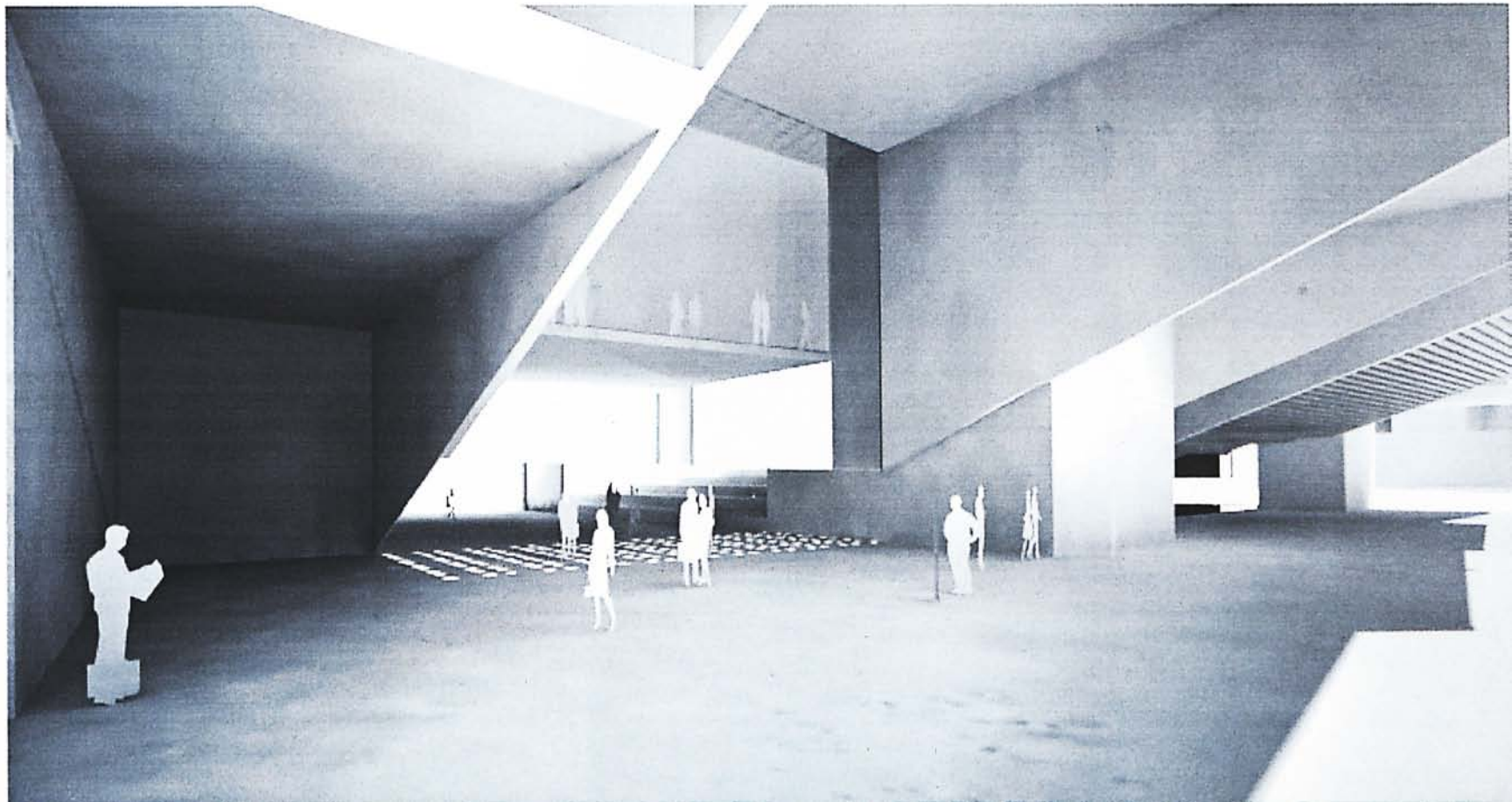
62

Plaza Entrance

[chopped incline surface create a canopy ; light shining down via the lightwell marking the entrance]

+ Big and Tall with Inclined arm wall
+ Outdoor Fresh Air
+ External Light / Diffused Light form Lightwell behind the hanging glass
+ To be seen / To walk through
+ via Vertical Cores





43 Bridge Entrance

[to be a linear tall space to bring people up to upper level]

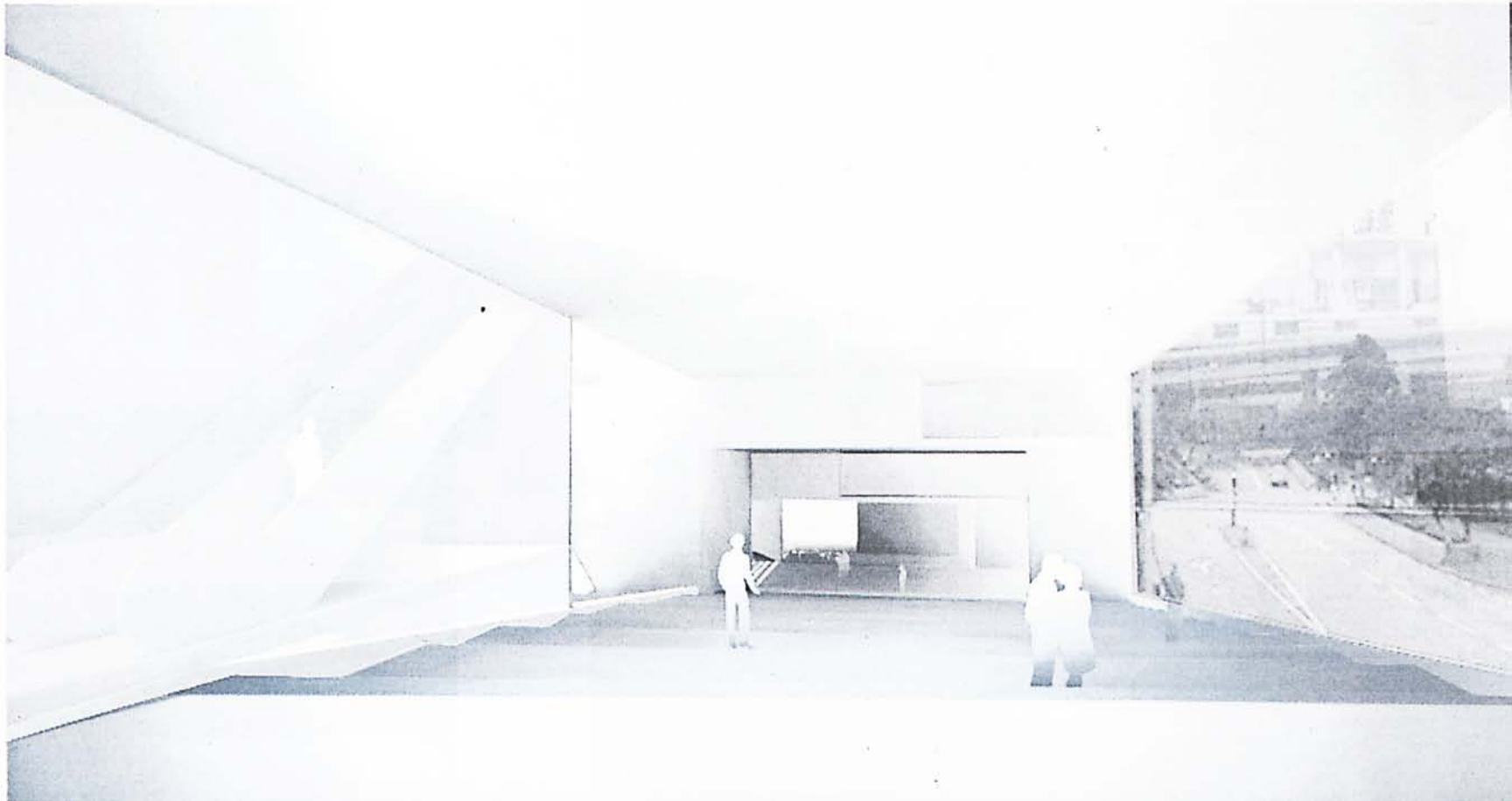
+ Tall and Thin
+ Indoor
+ External Light from 2 narrow sides
+ To walk through / To see through the space behind
+ via Bridge / Corridor

32

Cascade

[to be an indoor public plaza with sitting steps for casual encountering and public events ; it is also a circulation connecting people from bridge level to the opposite end at ground level]

+ Big and Long with Inclined steps
+ Indoor
+ External Light from 2 sides
+ To be seen / To walk through / To stay in / To view activities in surrounding rooms
+ via Bridge / Vertical Cores

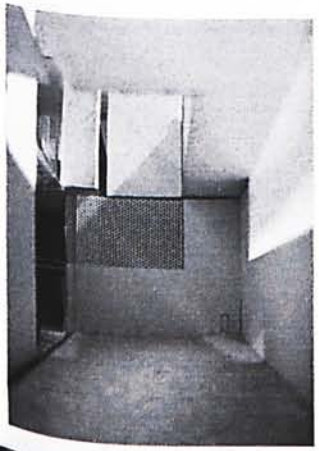


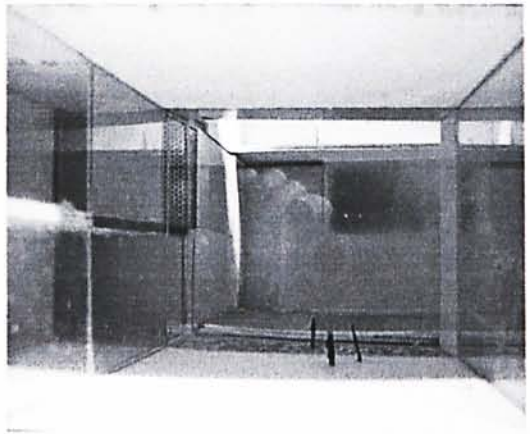
7.9

Tennis Court

[to act as an open ground for sport and movement]

+ Big and Tall (uncovered)
+ Outdoor Fresh Air
+ External Light
+ To be seen / Allow surrounding rooms access to light, air and view
+ via Corridor

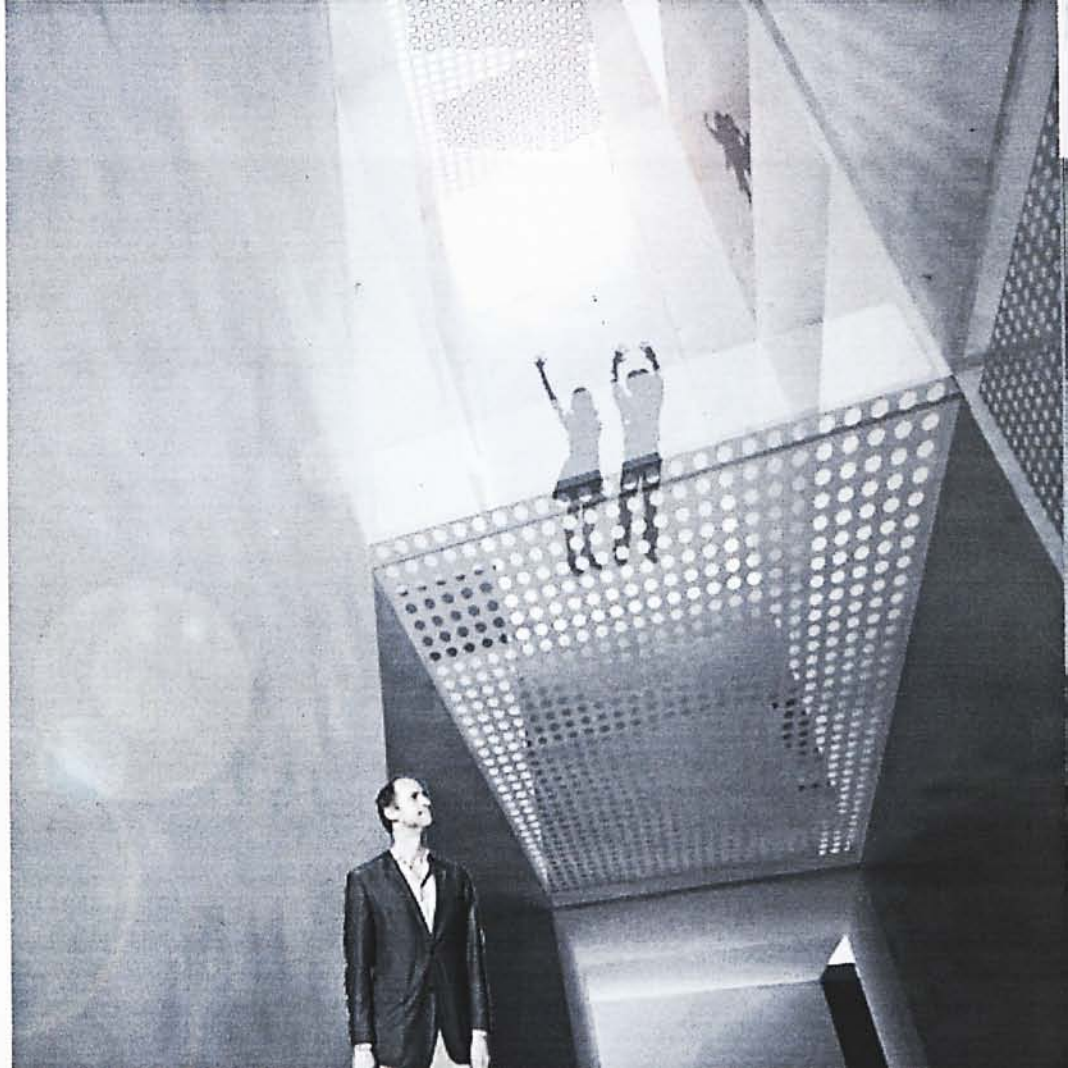




Vertical Void

[to be void for light and air ; review the vertical movement at various levels]

+ Tall and Thin
+ Outdoor
+ Diffused Light
+ To view and walk through
+ Vertical Core / Rooms / Shortcut Staircase

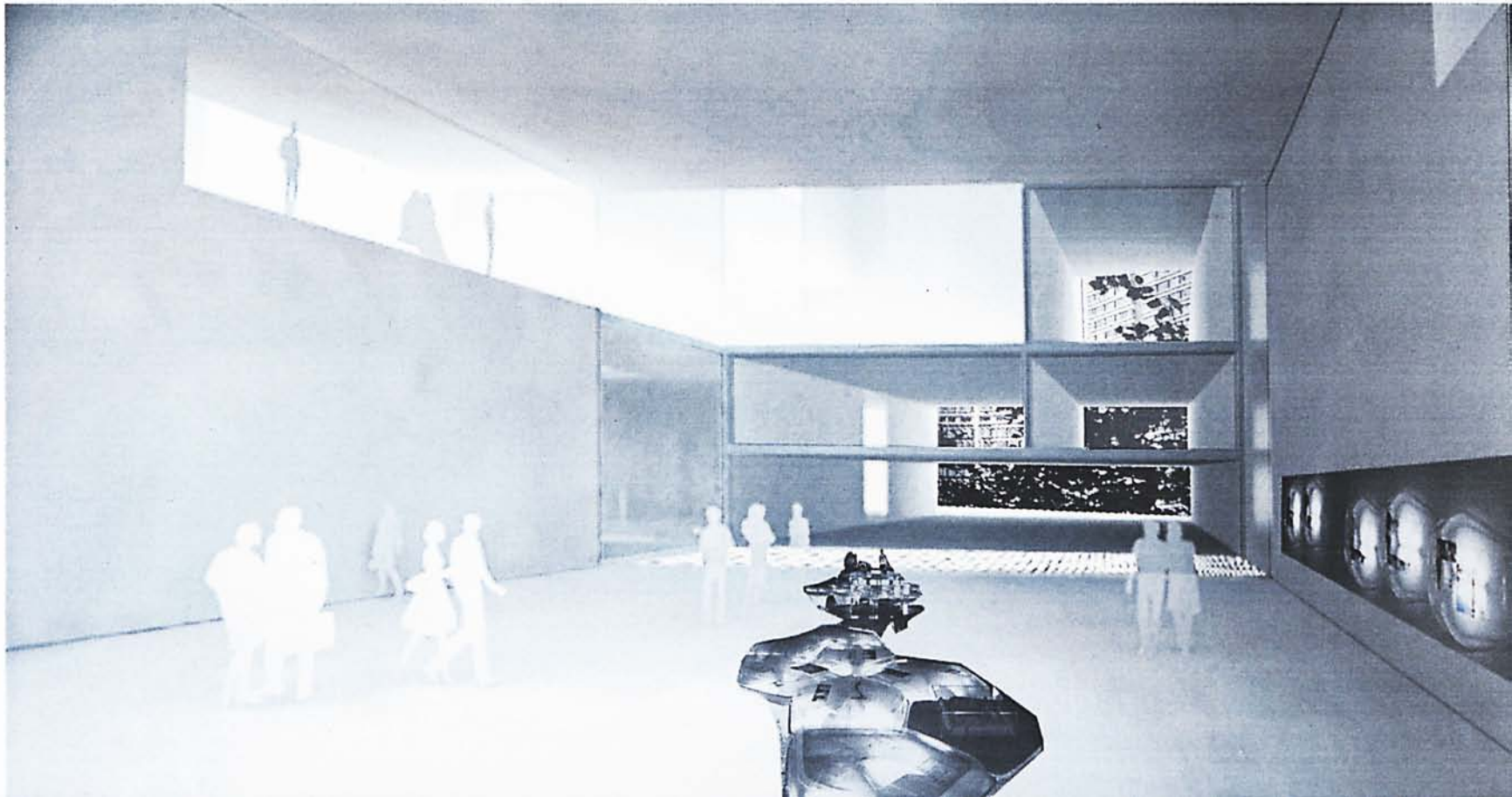


89

Event Hall

[to be large multi-function room for big event such as banquet, exhibition, student forum, party, market, etc.]

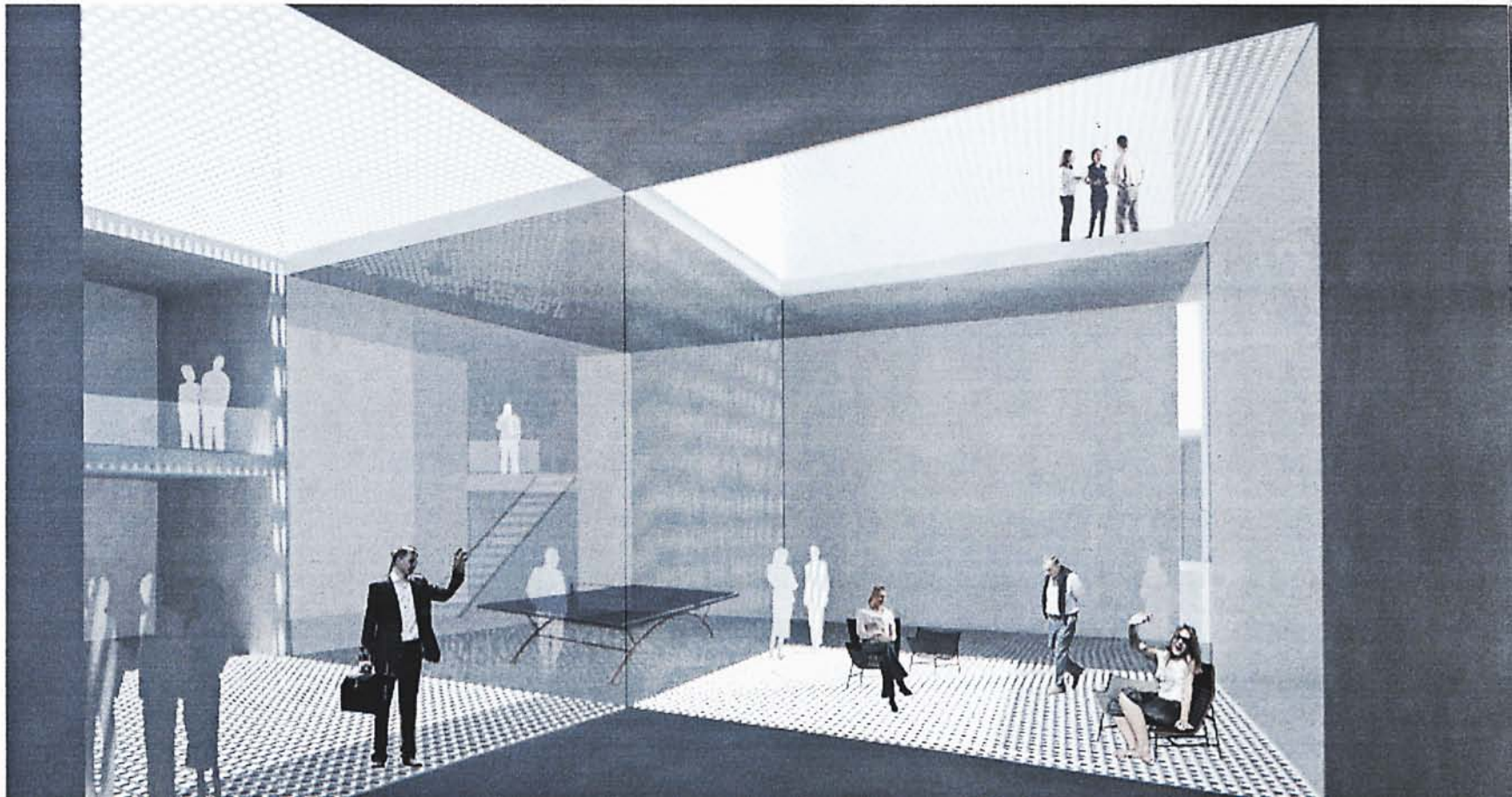
+ Big and Long
+ Indoor
+ External Light / Diffused Light from Lightwell
+ To be seen / To view through
+ via Vertical Cores / Rooms / Corridors



Courtyard Void

[to be light and air source for internal spaces]

+ Medium and Box-like
+ Outdoor
+ Diffused Light
+ To view through / To stay in
+ Vertical Core / Rooms

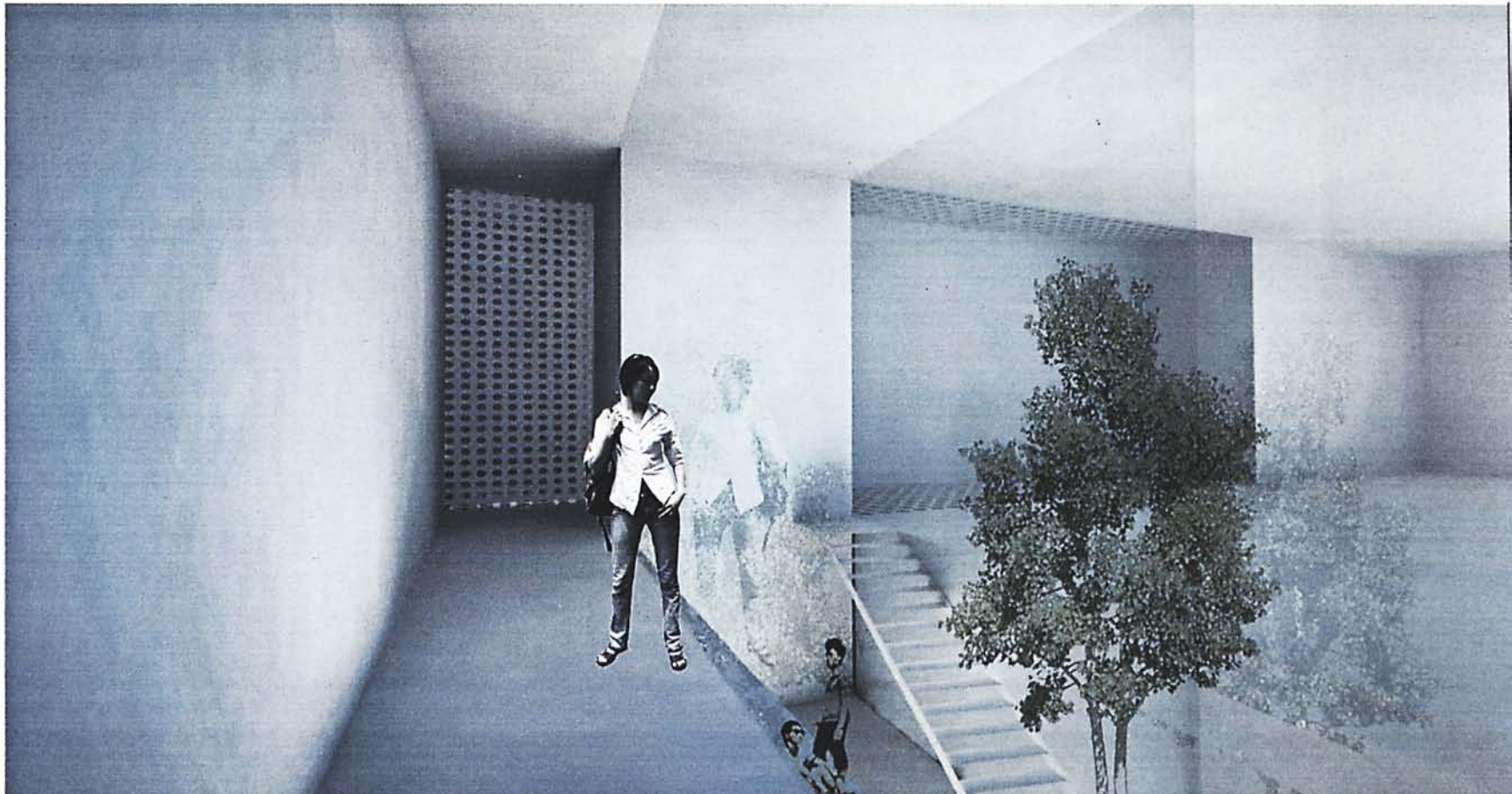


21.0

Communal Space

[to act as shortcut path to link up multiple floors and intimate meeting places for living zones]

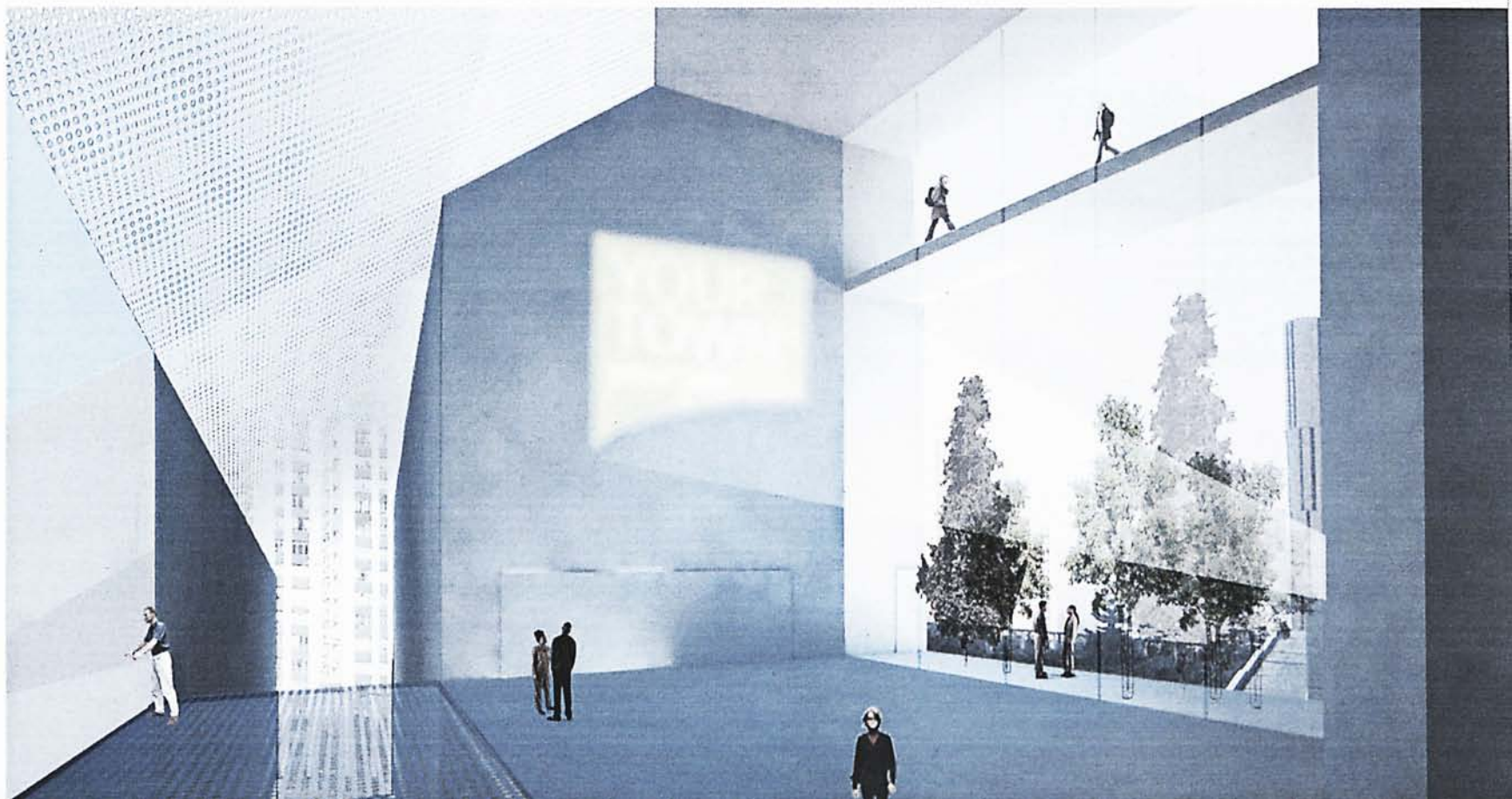
+ Small and Linear
+ Half Outdoor / Half Indoor
+ External Light
+ To be seen / To stay in / Get good external view
+ via Shortcut Staircase / Corridors / Rooms



3.8 Canteen

[to be major gathering space with fairly good quality of view]

+ Big (half covered, half open)
+ Half Outdoor, Half Indoor
+ External Light
+ To stay in / To view out
+ via Rooms / Corridor / Shortcut Staircase



SPECIAL STUDY

Documentation of Design Making (Process & Methodology)

Site Condition vs Massing
Spatial Organization vs Differentiation Principle
Program Distribution vs View Openness

//Design Methodology

Considering numerous possibilities, some significant external factors are chosen that a series of logics can be developed to manipulate the associated parameters, in order to generate PARAMETRIC VARIATIONS at different levels which result into a parametric design with complexity of spatial organization

Architect's mind
(interpretation of factors to develop a logic for the machine)
+Define Factors
+Define Parameters
+Design Machines

FACTORS

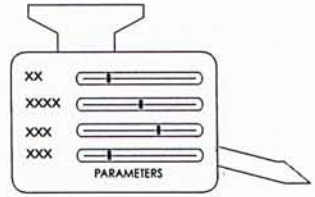
Site Condition
+ Urban Visibility
+ Urban Publicity
+ Urban Accessibility
+ Shadow

Spatial Organization
+ Spatial Types

View Openness
+ Max Viewing Distance
+ Location of points
+ Viewing Direction
+ Viewing Angle
+ Resolution

Re-interpretation and communication

+ Selection Process / Decision Making
+ Interpretation of Variations into Architecture



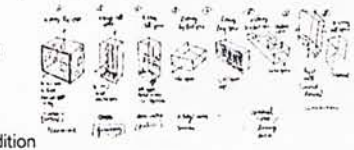
Paramatric machine
(Data anlaysis / manipulation of associated parameters to generate variations)
+ Data Processing
+ Generate Variations

PARAMETRIC VARIATIONS

Massing
+ Building Volume
+ Building Edge
+ Shadow Casting Line

Differentiation Principle
+ Starting position
+ Spreading direction
+ Division proportion
+ Number of division
+ Acceleration rate

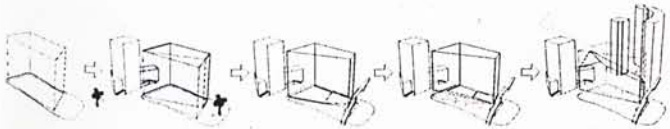
Program Distribution & Spatial Quality
+ Space Proportion
+ Air Condition
+ Light Condition
+ View Condition
+ Connection Condition

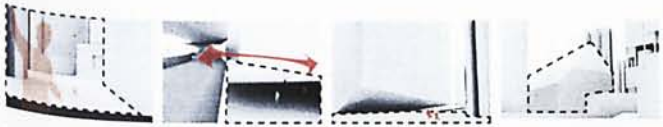


\\Site Condition VS Massing

Phase 1 - Exploration on Massing Manipulation as Site Responses

Various urban FACTORS are considered and interpreted to see how they can affect the parameters of the massing





Widen up the separation from the residential buildings on the South edge;
Build up visual connection with the education building and the green belts on 2 sides

Connect building to the footbridge level and bring people down to the academic building behind; Reveal more setback area on ground

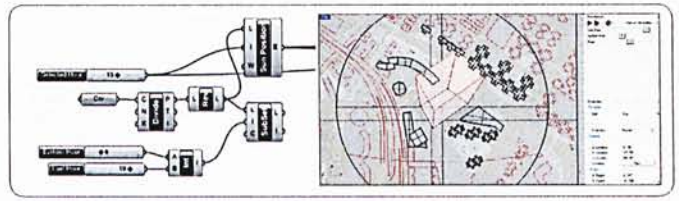
Further setback to create more covered outdoor seating area in the plaza and as a welcoming gesture

Sloped roof allows more sunlight to reach to the lower end of the buildings on the North edge in winter time;
Higher building height on Southwest side creates visual connection from MTR dropoff area across the highway

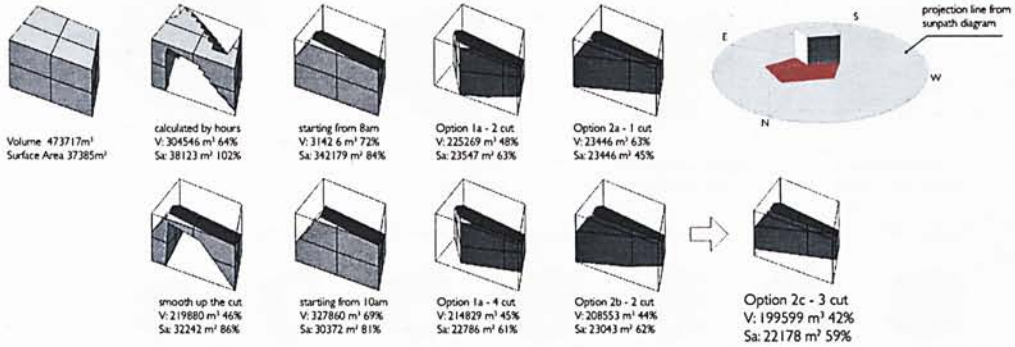
Physical Site Model 1:1000

Phase 2 - Designing Parameters

+ Building Volume
+ Building Edge
+ Shadow Casting Line



Massig can be manipulated with direct reflection on the volumes, surface area and shadow cast situation for judgement

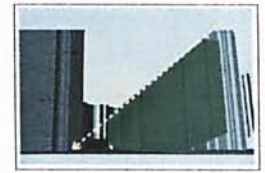


\\ Movie clips from animation

Urban Visibility

Urban Publicity

Urban Accessibility



Shadow

Part II Architectural Project : Parametric Design

v

Special Study
- Site Condition vs Massing
- **Spatial Organization vs Differentiation Principle**
- Program Distribution vs View Openness

iv Thesis Abstract, Reference Article, Timeline Schedule, Presentation Materials

iv Architectural Project: Early Development, Drawings & Photos, Spatial Sequence

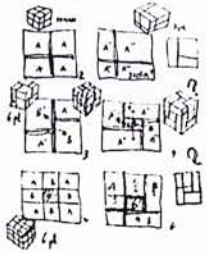
\\Spatial Organization VS Differentiation Principle

- Control division parameters to negoitate with function and viewing quality

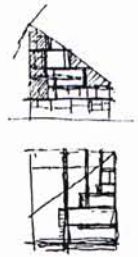
Phase 1 - Spatial Exploration with Physical Models

Various ways of subdivision are considered and tested to see how they can affect the parameters of spatial relationship and organization

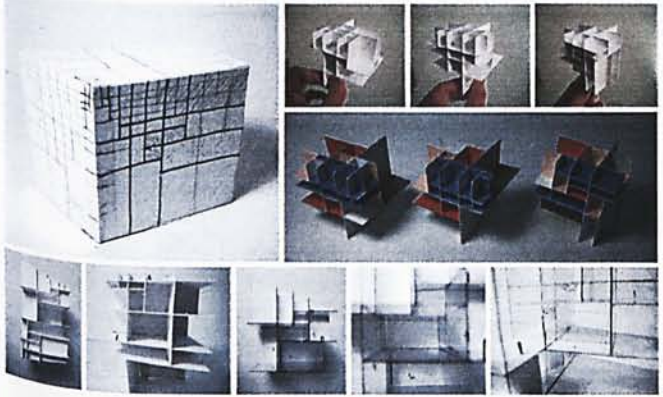
Diversity / Differentiation of spaces
CONCEPT : Non-hierarchical Structure



Different ways of Subdivision

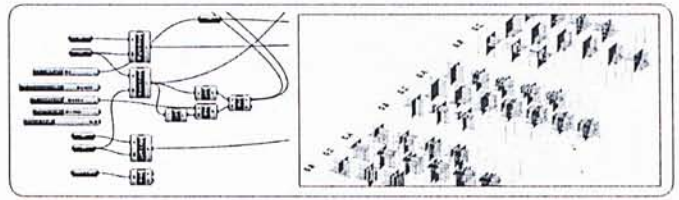


Sectional Relationship

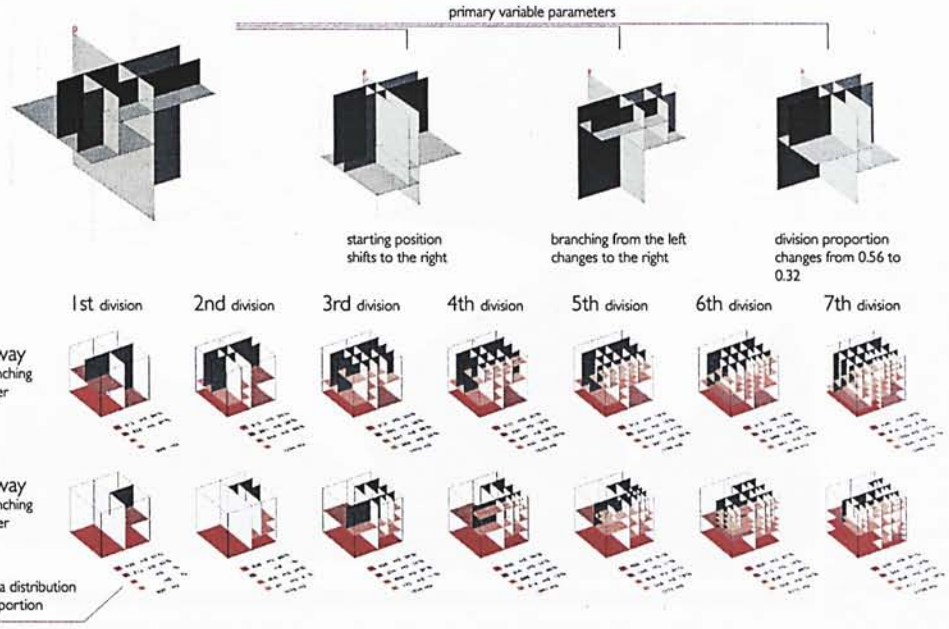


Phase 2 - Designing Parameters

+ Starting position
+ Spreading direction
+ Division proportion
+ Number of division
+ Acceleration rate

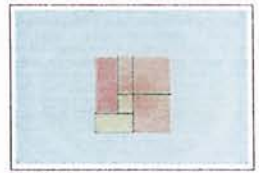


Branching Method is designed with 3 primary variable parameters, to be changed according to different program needs

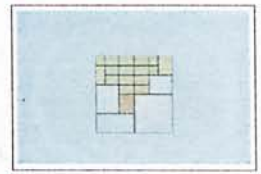


\\ Movie clips from animation

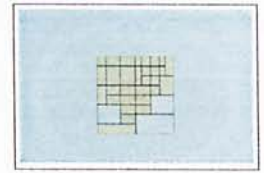
1st Division



2nd Division



5th Division



7th Division

Part II Architectural Project : Parametric Design

Special Study
- Site Condition vs Massing
- Spatial Organization vs Differentiation Principle
- **Program Distribution vs View Openness**

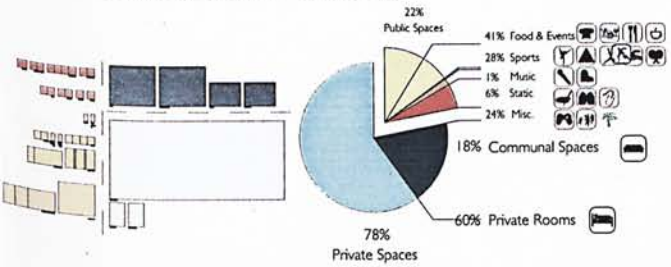
Xtra
- Thesis Abstract
- Reference Article
- Timeline Schedule
- Presentation Materials

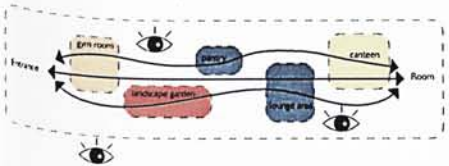
Architectural Project
- Early Development
- Drawings & Photos
- Spatial Sequence

\\Program Distribution VS View Openness

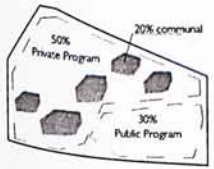
- Calculate view openness index <> Program Distribution

Phase 1 - Program Study and its Correlation

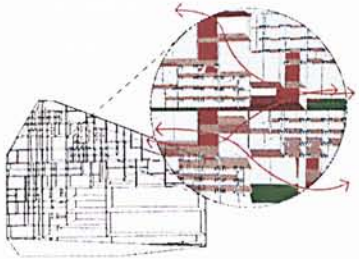




Another way of organization to promote of social living, causal encountering and visual connections with inside and outside environment by multiple paths, mingling the programs and provide variety of spatial relationship.



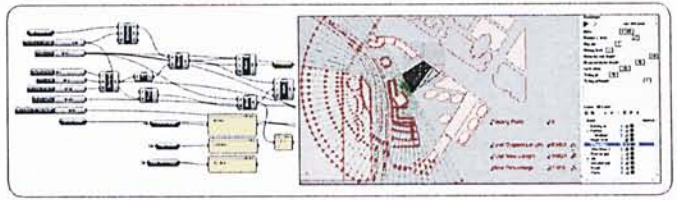
Initial idea for sudivision proportion



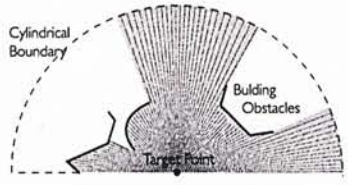
Examine the merged internal spatial relationship emerged from the subdivisions

Phase 2 - Designing Parameters

- + Max Viewing Distance
- + Location of points
- + Viewing Direction
- + Viewing Angle
- + Resolution

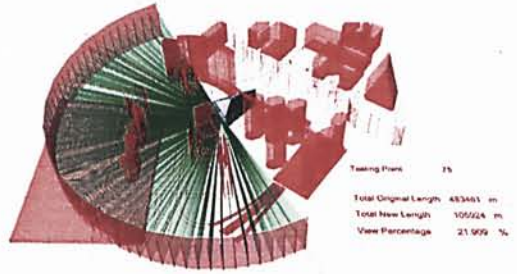


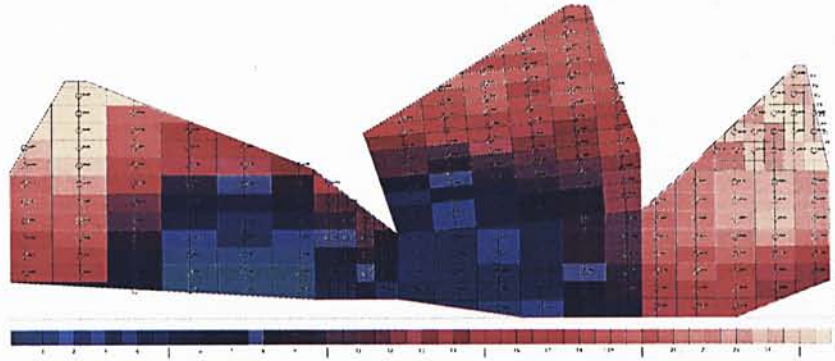
View Openness Calculation is done to obtain the color chart as an indicator for Internal Space Subdivision Order



View Openness Percentage (1-100%)

$$\frac{\text{Total Vision Distance with Obstacles}}{\text{Total Vision Distance without Obstacles}} \times 100\%$$





Unfolded Elevation using color to represent the View Openness Index Value

\\ Movie clips from animation

View Openness Percentage

Differentiation as a whole

Cluster of bigger rooms at low value portion

Cluster of smaller rooms at higher value portion

XTRA

Appendix

\\Thesis Abstract

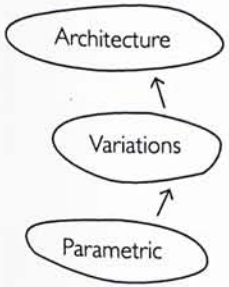
Parametric Variation in Architecture

from **Designing parameter** to **Parametric design**

WONG, Chui-kwan Alice

The fundamental of parametric design is defining a description of a changeable dynamic system vared by its variables(parameters). My thesis is to explore the complexity of spatial organization achieved by parametric variations.

*"Variations are important in achieving complexity. However, the idea of design should not be merely the use of rules and the consequent variations that emerge out of the parameters. Besides, variations alone are not enough to support complexity. The use of rules generally also eliminates ambiguity from the design process unless these are non-deterministic. Without an element of surprise, discovery or in other words controlled ambiguity the designer will be in a position to predict the outcome – something that defies one of the essential notions of design, namely to **"invent"**. "* [6]



// What is happening now?

In the 21st century, the field of contemporary architectural design is sucked up with numerous self-claimed computational-related designs. The overflow of this particular series of architecture reveals the fact that technology has been undergoing an extremely fast evolution in the recent year. Many current practices and dominant architectural institutions have gradually realized the hidden crack that the related theoretical knowledge built up by practicing architects and academic students can hardly catch up with its speed of development. As a result, the term "digital cliché" emerges out to criticize those **computing designs without deep and innovative thought**, and the primarily use of the computer aids **as representational tools or form generators**. Digital design is falling into a trap being stylish and explicitly expressed as an image of indexing architecture. [1] Instead of creating new spaces, types of spaces and resulted forms are always determined or strictly constrained by the tools we knew and mastered. They could be recognized as similar designs or style partly related to more or less the same languages/techniques shared in the paradigm.

Indeed, there are many different voices in the architectural research field gives critical views. For instance, Patrik Schumacher, partner at Zaha Hadid Architects and a co-director of AA Design Research Lab, has once proposed 5 points to stimulate new aspects for the parametric paradigm to strengthen the future development of parametricism and elaborate parametricism as a mature and pervasive **manifesto**, another style to replace modernism. He also commented that parametricism can only exist via sophisticated parametric techniques. [2]

In the conversation between Sanford Kwinter and Jason Payne extracted from <<From Control to Design>>, Jason Payne (Principal of Hirsuta LLC and Adjunct Assistant Professor of Architecture, UCLA), without disregarding potentials and benefits of parametric paradigm in architecture, he "strongly believe(s) that its use should be background to a supporting role in contemporary indexical work" (p.224) and proposes "pragmatic indexicality" with an attitude - **"use when necessary and then move on"**. (p.222) Otherwise, instead of a complex and intricate design, superficial and over-complicated form is always the outcome. Neil Leach, an architect and theorist, was a co-curator with Xu Wei-Guo for the exhibitions at the Architecture Biennial Beijing 2004 and 2006. In the two biennials, many new developments done by research units of some leading offices, such as Advanced Geometry Unit at Arup or the Specialist, Modelling Group at Foster and Partners were presented. Students of the leading schools in all over the world doing work with a particular emphasis on the innovative use of new digital techniques were also collected as a huge catalogue[3], as if a Pandora's box of architectural tricks and treats, which seems set to spread like a virus across the full range of architectural production.

We are getting into a culture of digital tectonic. Having known the overall view, one can still hardly get rid of the impression of a kind of unwritten "code" for parametric architecture, which is "continuous differentiation" [4]. Some people name the theory behind as bottom-up, part-to whole or topological approach correlated to some biological phenomenons. In parametric sense, it is also vaild and feasible as within a certain range of values, the relationship between parts of a body is not necessarily described by only oppositional terms such as big or small, high or low, bright or dark, connected or disconnected. Instead, the body of a piece of architecture is always presented as a whole with a series of variations.

Nevertheless, facing so many exotic forms popping up, do we need to be more critical to those **indifferent variations**?

//My interest in the discourse?

This thesis is not aimed to criticize the existing parametric paradigm. Rather than that, it is an intention to leave it as an open question and explore the deeper meaning of **parametric design**, which may lead to a new perspective and cognition at the end. Although confronting with different opinions from differet sides, the prospects of parametric architecture is apparently promising and protruding. **The more important question to me is how to understand its fundamental to develop our own approach for architecture.**

- Parametric Variation -

Go back to the basis of parametric design, contrary to conventional way of design, its concept fundamentally is setting parameters to generate a series of variations with design aspirations.

"A **parameter** is basically a **variable** to which other variables are related by means of parametric equations, in such a way, design modification and creation of a family of component parts can be performed efficiently by setting up reconfigurable smart models capturing the underlying logic of the design." [5]

The architectural ISSUE to be studied is how the parametric mechanism is defined in order to eastablish a sophisticated and dynamic relationship between the parameters, and how to combine other mechanisms, e.g. manual, in relation to different stages in the design process in order to generate intricate and meaningful variations. That is

-When we use those prevailing computational tools, the question we frequently encountered is what we can do with the tools, but we seemingly forget about what we want/to do and design with the tool-

Therefore, not being aware of how we use it as a tool to be designed, many designers are suffered from digital obsession and being used by the tools unconsciously.

the pivot point determining the richness of a parametric design, ie. parametric architecture. Ultimately, the beauty of parametric architecture should not be determined by its exotic "parametric" form but demonstrated by the richness of the space emerged out of the simplicity in the logic of operations and the **complexity in variations.**

//Prescribed or Surprise?

"Scripting is a very simple thing an efficient way to produce differentiated repetition in digital modeling that would otherwise require a great deal of time and effort." [7]

We know that parameter itself is simple and straightforward because whatever fed into the computer needs to be strictly rational and logical in order to be scripted and being executed without errors. That is why algorithmic design is believed as a mean to produce complex forms by implementing relatively simple and easy formulas.

However, one may argue if scripting is only pragmatically executed to generate numerous **indifferent variations** without any **design insight**, "this often results in the addition of unnecessary layers of complexity to a project just for the sake of production of seemingly more complex forms. This in turn always degenerate to computational decoration and after taking into account all the layers of information, the resulting algorithms seems little different than a complicated random number generator." [8]

To avoid creating such kind of deceptive complexity and predictable result out of the rule, parametric design should be understood as a matter of more than simply generating design options and doing selection. It is very much about the organization of given information and the design of parametric attributes. As a MEAN, parametric scripting is neutral in nature. Its significance is allowing us to create tools we want. The deterministic point is whether the designer is actively or passively engaged and and uses the parametric means in a sensitive manner according to different stages in the design process.

A major OBJECTIVE of the thesis is to clarify how to achieve a complex parametric architecture which is not merely a visualization of a set of rules and a literal result of the variations generated out of the parameters. The focus of the thesis will be more on the creative aspects of parametric architectural design process contributed to the creation of variations, instead of, but without disregard, the usual application of parametric design in the post-architectural process, cost optimization process, structural realization or rationalization process.

- METHODOLOGY -

Part I Variations in parametric approach

In the first part of the thesis, the focus will be designing the parameters, searching some mechanisms or tools for generating variations as design inputs. It is intended to explore the possibilities to create meaningful interrelationship of the parameters in order to enhance the complexity, contrary to solving problems incrementally (linearly) in conventional way. The representation and interpretation of the information will be an important step for moving on to the second part of the thesis.

In term of tool, the thesis will focus on the use of Rhinoceros, a stand-alone, commercial NURBS-based 3-D modeling tool, because of its capacity for various purpose-oriented plug-ins which may allow higher level of flexibility. WIP Grasshopper for parametric modeling will be explored. For the realization of the project, other digital applications may be introduced.

Part 2 Parametric variations in Architecture

In the second part of the thesis, the focus will be how to get the parameters involved into the architectural design process. A SCENARIO will be chosen to test out the strategy in a kind architecture incorporated with a large quantity set of varied units/variations.

REFERENCE

1. In <<From Control to Design>>, A conversation between Sanford Kwinter and Jason Payne, this dramatic change in the way of doing design is correlated to the situation that we are now undergoing a so-called "third generation of indexicality". One of the main impacts of this generation is that students "appear to have accepted indexing as a method unconditionally, largely without the critical perspective or the spirit of philosophical inquiry brought to it by their predecessors."

2. Parametricism as Style - Parametricist Manifesto Patrik Schumacher, London 2008

3. (Im)material processes - New digital teachiques for architecture 数字建构, Neil leach & Xu Wei Guo

4. Greg Lynn, in Folds, Bodies, Blobs - Body Matters

5. From Control to Design, Open systems: approaching novel parametric domains, Marco Vanucci, P118

6. Parametric Design – a Paradigm by Victor Gane June 2004, P.16

7. From Control to Design, A conversation between Sanford Kwinter and Jason Payne, P.224

8. From Control to Design, Simplexity, Sawako + Michalatos Panagiots, P130

Others

Tooling, by Aranda/lasch 2005

Parametricism as Style

- Parametricist Manifesto

Patrik Schumacher, London 2008
Presented and discussed at the Dark Side Club I ,
11th Architecture Biennale, Venice 2008
http://www.patrikschumacher.com/Texts/Parametricism%20as%20Style.htm

We pursue the parametric design paradigm all the way, penetrating into all corners of the discipline. Systematic, adaptive variation, continuous differentiation (rather than mere variety), and dynamic, parametric figuration concerns all design tasks from urbanism to the level of tectonic detail, interior furnishings and the world of products.

Architecture finds itself at the mid-point of an ongoing cycle of innovative adaptation – retooling the discipline and adapting the architectural and urban environment to the socio-economic era of post-fordism. The mass society that was characterized by a single, nearly universal consumption standard has evolved into the heterogenous society of the multitude.
The key issues that avant-garde architecture and urbanism should be addressing can be summarized in the slogan: organising and articulating the increased complexity of post-fordist society. The task is to develop an architectural and urban repertoire that is geared up to create complex, polycentric urban and architectural fields which are densely layered and continuously differentiated.

Contemporary avant-garde architecture is addressing the demand for an increased level of articulated complexity by means of retooling its methods on the basis of parametric design systems. The contemporary architectural style that has achieved pervasive hegemony within the contemporary architectural avant-garde can be best understood as a research programme based upon the parametric paradigma. We propose to call this style: Parametricism.
Parametricism is the great new style after modernism. Postmodernism and Deconstructivism have been transitional episodes that ushered in this new, long wave of research and innovation.

Avant-garde styles might be interpreted and evaluated in analogy to new scientific paradigms, affording a new conceptual framework, and formulating new aims, methods and values. Thus a new direction for concerted research work is established.[2]
My thesis is therefore: Styles are design research programmes.[3]
Innovation in architecture proceeds via the progression of styles so understood. This implies the alternation between periods of cumulative advancement within a style and revolutionary periods of transition between styles. Styles represent cycles of innovation, gathering the design research efforts into a collective endeavor. Stable self-identity is here as much a necessary precondition of evolution as it is in the case of organic life. To hold on to the new principles in the face of difficulties is crucial for the chance of eventual success. This tenacity - abundantly evident within the contemporary avant-garde - might at times appear as dogmatic obstinacy. For instance, the obstinate insistence of solving everything with a folding single surface - project upon project, slowly wrenching the plausible from the implausible – might be compared to the Newtonian insistence to explain everything from planets to bullets to atoms in terms of the same principles.
"Newton's theory of gravitation, Einstein's relativity theory, quantum mechanics, Marxism, Freudianism, are all research programmes, each with a characteristic hard core stubbornly defended, … each with its elaborate problem solving machinery. Each of them, at any stage of its development, has unsolved problems and undigested anomalies. All theories, in this sense, are born refuted and die refuted."[4] The same can be said of styles: Each style has its hard core of principles and a characteristic way of tackling design problems/tasks. Avant-garde architecture produces manifestos: paradigmatic expositions of a new style's unique potential, not buildings that are balanced to function in all respects. There can be neither verification, nor final refutation merely on the basis of its built results.[5]
The programme/style consists of methodological rules: some tell us what paths of research to avoid (negative heuristics), and others what paths to pursue (positive heuristics). The negative heuristics formulates strictures that prevent the relapse into old patterns that are not fully consistent with the core, and the positive heuristics offers guiding principles and preferred techniques that allow the work to fast-forward in one direction. The defining heuristics of parametricism are fully reflected in the taboos and dogmas of contemporary avant-gared design culture:
Negative heuristics: avoid familiar typologies, avoid platonic/hermetic objects, avoid clear-cut zones/territories, avoid repetition, avoid straight lines, avoid right angles, avoid corners, …, and most importantly: do not add or subtract without elaborate interarticulations.
Positive heuristics: interarticulate, hyberdize, morph, deterritorialize, deform, iterate, use splines, nurbs, generative components, script rather than model, …

Parametricism is a mature style. That the parametric paradigm is becoming pervasive in contemporary architecture and design is evident for quite some time. There has been talk about versioning, iteration and mass customization etc. for quite a while within the architectural avant-garde discourse.
The fundamental desire that has come to the fore in this tendency had already been formulated at the beginning of the 1990s with the key slogan of "continuous differentiation"[6]. Since then there has been both a widespread, even hegemonic dissemination of this tendency as well as a cumulative build up of virtuosity, resolution and refinement within it. This development was facilitated by the attendant development of parametric design tools and scripts that allow the precise formulation and execution of intricate correlations between elements and subsystems. The shared concepts, computational techniques, formal repertoires,

and tectonic logics that characterize this work are crystallizing into a solid new hegemonic paradigm for architecture. One of the most pervasive current techniques involves populating modulated surfaces with adaptive components.Components might be constructed from multiple elements constrained/cohered by associative relations so that the overall component might sensibly adapt to various local conditions. As they populate a differentiated surface their adaptation should accentuate and amplify this differentiation. This relationship between the base component and its various instantiations at different points of insertion in the "environment" is analogous to the way a single geno-type might produce a differentiated population of pheno-types in response to divers environmental conditions.

The current stage of advancement within parametricism relates as much to the continuous advancement of the attendant computational dresign technologies as it is due to the designer's realization of the unique formal and organizational opportunities that are afforded. Parametricism can only exist via sophisticated parametric techniques. Finally, computationally advanced design techniques like scripting (in Mel-script or Rhino-script) and parametric modeling (with tools like GC or DP) are becoming a pervasive reality. Today it is impossible to compete within the contemporary avant-garde scene without mastering these techniques.
Parametricism emerges from the creative exploitation of parametric design systems in view of articulating increasingly complex social processes and institutions. The parametric design tools by themselves cannot account for this drastic stylistic shift from modernism to parametricism. This is evidenced by the fact that late modernist architects are employing parametric tools in ways which result in the maintenance of a modernist aesthetics, i.e. using parametric modelling to inconspicuously absorb complexity. Our parametricist sensibility pushes in the opposite direction and aims for a maximal emphasis on conspicuous differentiation.
It is the sense of organized (law-governed) complexity that assimilates parametricist works to natural systems, where all forms are the result of lawfully interacting forces. Just like natural systems, parametricist compositions are so highly integrated that they cannot be easily decomposed into independent subsystems – a major point of difference in comparison with the modern design paradigm of clear separation of functional subsystems.

The following 5 agendas might be proposed here to inject new aspects into the parametric paradigm and to push the development of parametricism further:

1.Inter-articulation of sub-systems:
The ambition is to move from single system differentiation – e.g. a swarm of façade components - to the scripted association of multiple subsystems – envelope, structure, internal subdivision, navigation void. The differentiation in any one systems is correlated with differentions in the other systems.

2. Parametric Accentuation:
The ambition is to enhance the overall sense of organic integration through intricate correlations that favour deviation amplification rather than compensatory or ameliorating adaptations. For instance, when generative components populate a surface with a subtle curvature modulation the lawful component correlation should accentuate and amplify the initial differentiation. This might include the deliberate setting of accentuating thresholds or singularities.Thus a far richer articulation can be achieved and thus more orienting visual information can be made available.

3. Parametric Figuration[7]:
We propose that complex configurations that are latent with multiple readings can be constructed as a parametric model. The parametric model might be set up so that the variables are extremely Gestalt-sensitive. Parametric variations trigger gestalt-catastrophes, i.e. the quantitative modification of these parameters trigger qualitative shifts in the perceived order of the configuration.This notion of parametric figuration implies an expansion in the types of parameters considered within parametric design. Beyond the usual geometric object parameters, ambient parameters (variable lights) and observer parameters (variable cameras) have to considered and integrated into the parametric system.

4. Parametric Responsiveness[8]:
We propose that urban and architectural (interior) environments can be designed with an inbuilt kinetic capacity that allows those environments to reconfigure and adapt themselves in response to the prevalent patterns of use and occupation. The real time registration of use-patterns produces the parameters that drive the real time kinetic adaptation process. Cumulative registration of use patterns result in semi-permanent morphological transformations. The built environment acquires responsive agency at different time scales.

5. Parametric Urbanism[9]:
The assumption is that the urban massing describes a swarm-formation of many buildings.These buildings form a continuously changing field, whereby lawful continuities cohere this manifold of buildings. Parametric urbanism implies that the systematic modulation of the buildings' morphologies produces powerful urban effects and facilitates field orientation. Parametric Urbanism might involve parametric accentuation, parametric figuration, and parametric responsivess.

Modernism was founded on the concept of space. Parametricism differentiates

fields. Fields are full, as if filled with a fluid medium. We might think of liquids in motion, structured by radiating waves, laminal flows, and spiraling eddies. Swarms have also served as paradigmatic analogues for the field-concept. We would like to think of swarms of buildings that drift across the landscape. Or we might think of large continuous interiors like open office landscapes or big exhibition halls of the kind used for trade fairs. Such interiors are visually infinitely deep and contain various swarms of furniture coalescing with the dynamic swarms of human bodies. There are no platonic, discrete figures with sharp outlines. Within fields only the global and regional field qualities matter: biases, drifts, gradients, and perhaps even conspicuous singularities like radiating centres. Deformation does no longer spell the breakdown of order but the lawful inscription of information. Orientation in a complex, lawfully differentiated field affords navigation along vectors of transformation .The contemporary condition of arriving in a metropolis for the first time, without prior hotel arrangements, without a map, might instigate this kind of field-navigation. Imagine there are no more landmarks to hold on, no axis to follow and no more boundaries to cross. Contemporary architecture aims to construct new logics – the logic of fields – that gear up to organize and articulate the new level of dynamism and complexity of contemporary society.

Furniture and product design fully participates in the parametricist agenda we are pursuing. We consider furniture not in terms of isolated objects but as a pre-eminent space-making substance. Our design efforts need to encompass the domains of interior design, furniture design, and even product design. We can orchestrate all those registers to advance the design of integrated, immersive worlds. Our handling of interior furnishings as dynamic swarm formations, or sometimes as a continuous surface/fluid mass, is geared towards the detailed elaboration of the continuously differentiated fields described above.

NOTES:

1 The Dark Side Club is a critical salon initiated and organized by Robert White to coincide with the Architecture Biennale. Three successive events were onceived as a critical salon to debate some of the themes Aaron Betsky had set for this year's Biennale. Three curators have been invited to each put forward a proposition for debate: Patrik Schumacher, Greg Lynn, and Gregor Eichinger. Each invited young architects and thinkers to debate the direction architecture is taking.
The first session – curated and introduced by Patrik Schumacher was titled: Parametricism as New Style. The following 8 architectural studios were presenting: MAD, f-u-r, UFO, Plasma Studio, Minimaforms, Aranda/Lasch, AltN Research+Design, MOH. Jeff Kipnis acted as moderator.

2 This interpretation of styles is valid only with respect to the avant-garde phase of any style.

3 It is important to distinguish between research programmes in the literal sense of institutional research plans from the meta-scientific conception of research programmes that has been introduced into the philosophy of science: whole new research traditions that are directed by a new fundamental theoretical framework. It is this latter concept that is utilized here for the reinterpretation of the concept of style. See: Imre Lakatos, The Methodology of Scientific Research Programmes, Cambridge 1978

4 Lakatos, Imre, The Methodology of Scientific Research Programmes, Cambridge 1978, p.5

5 The final reckoning takes place later, in the arena of the mainstream adoption which only indirectly feeds back into the central, discursive arena of the discipline.

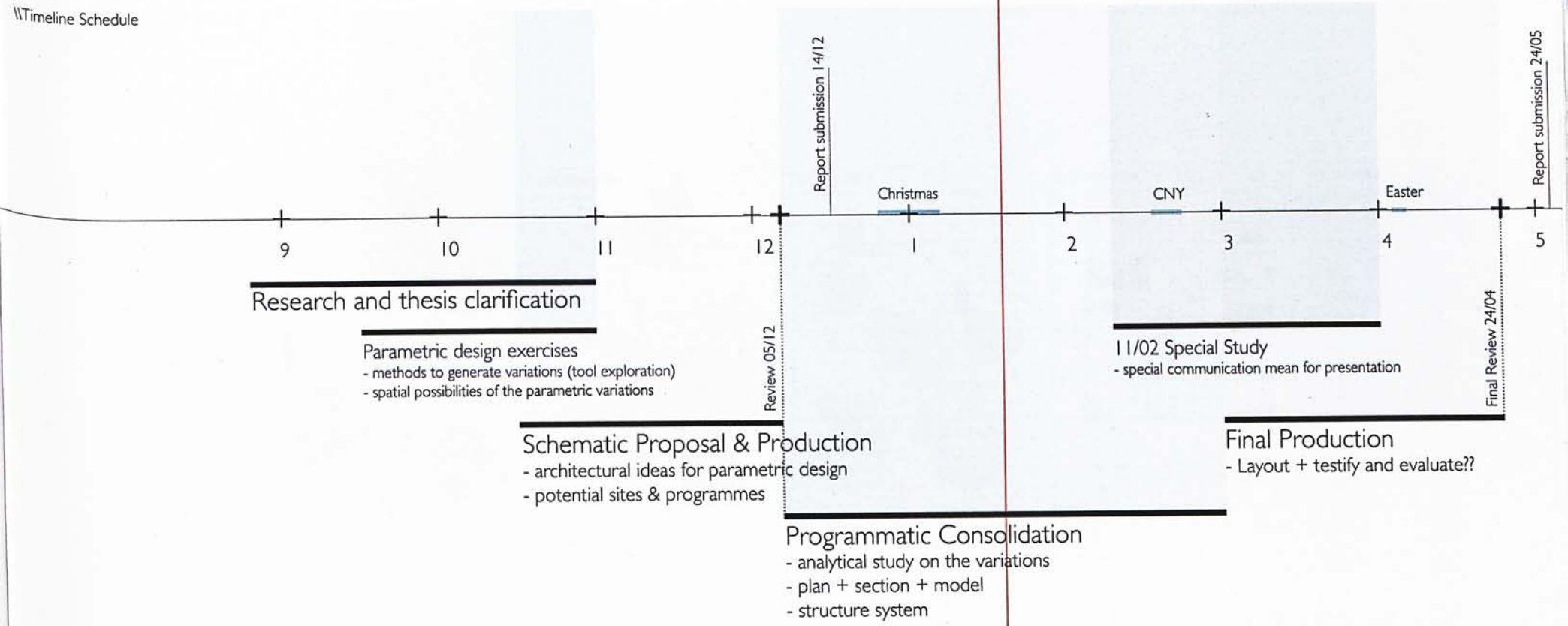
6 The credit for coining this key slogan goes to Greg Lynn and Jeff Kipnis.

7 "Parametric Figuration" featured in our teachings at Yale and at the University of Applied Arts, Vienna. It also featured in my studio at the AADRL.

8 Parametric Responsiveness was at the heart of our 3 year design research agenda "Responsive Environments" at the AADRL in London from 2001-2004.

9 "Parametric Urbanism" is the title of our recently completed design research cycle at the AADRL, from 2005 – 2008.

\\Timeline Schedule



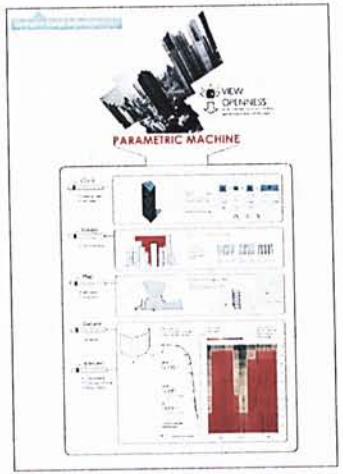
Part II Architectural Project : Parametric Design

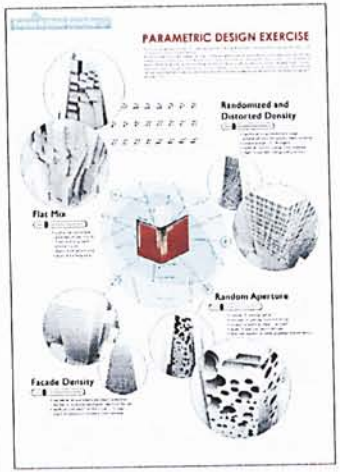
Xtra
- Thesis Abstract
- Reference Article
- Timeline Schedule
- **Presentation Materials**

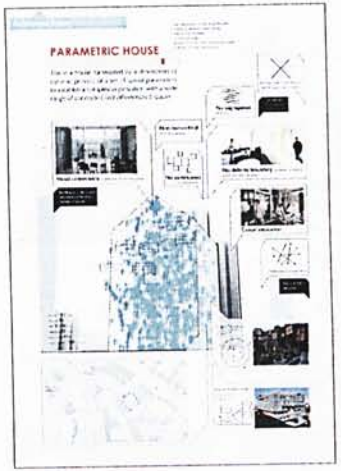
Architectural Project
- Early Development
- Drawings & Photos
- Spatial Sequence

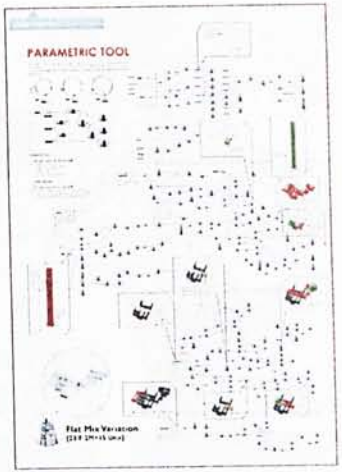
Spatial Study
- Site Condition vs Massing
- Spatial Organization vs Differentiation Principle
- Program Distribution vs View Openness

\\Sem I Final Review -
Presentation Posters









Part II Architectural Project : Parametric Design

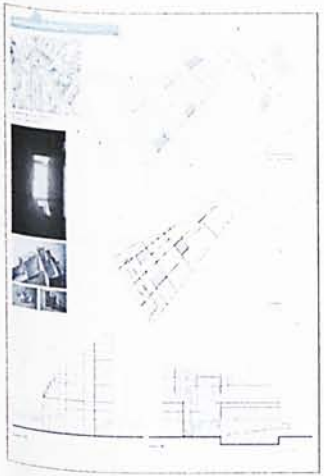
Xtra
- Thesis Abstract
- Reference Article
- Timeline Schedule
- **Presentation Materials**

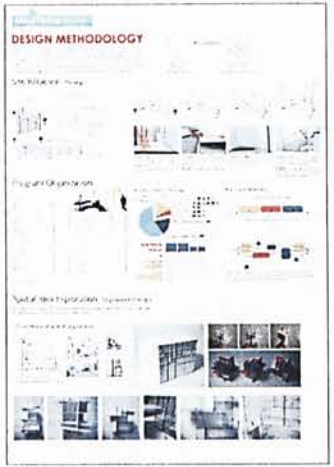
IV Architectural Project
- Early Development
- Drawings & Photos
- Spatial Sequence

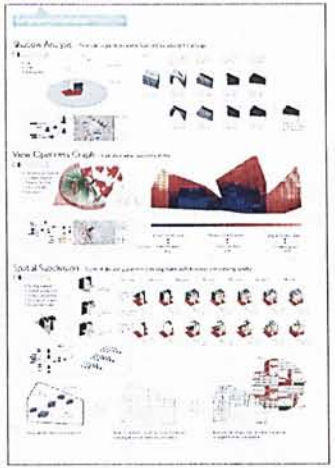
V Special Study
- Site Condition vs Planning
- Spatial Organization vs Differentiation Principle
- Program Distribution vs View Openness

\\Sem 2 Interim Review - Presentation Posters

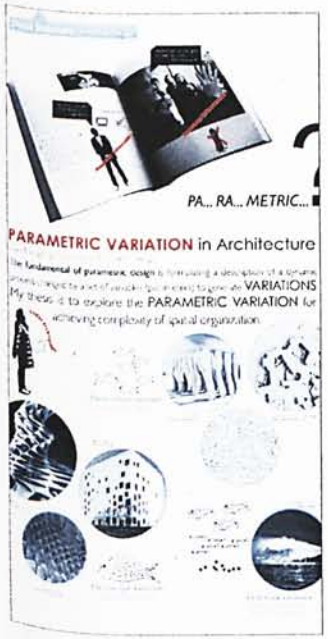
\\DLN Awards Special Studies - Shaping Cities

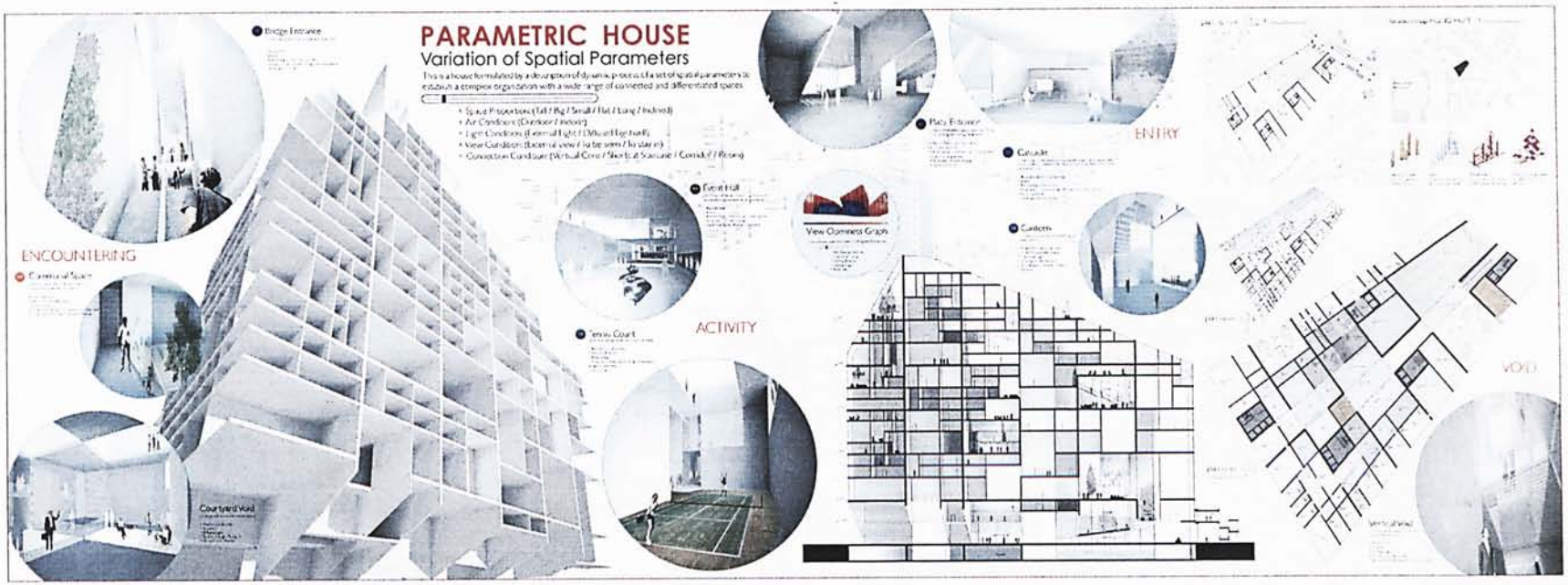




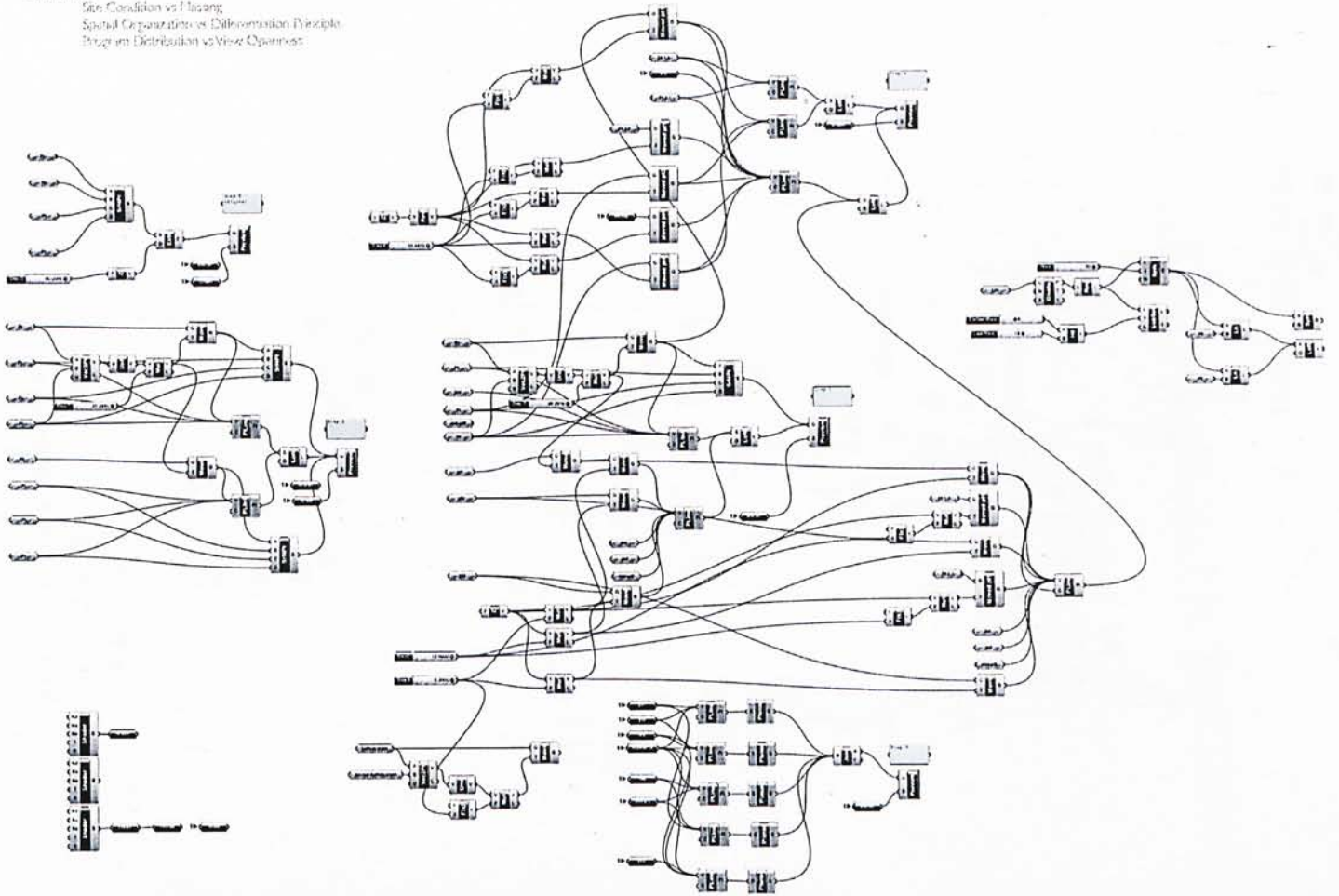


\\Sem 2 Final Review -
Presentation Posters



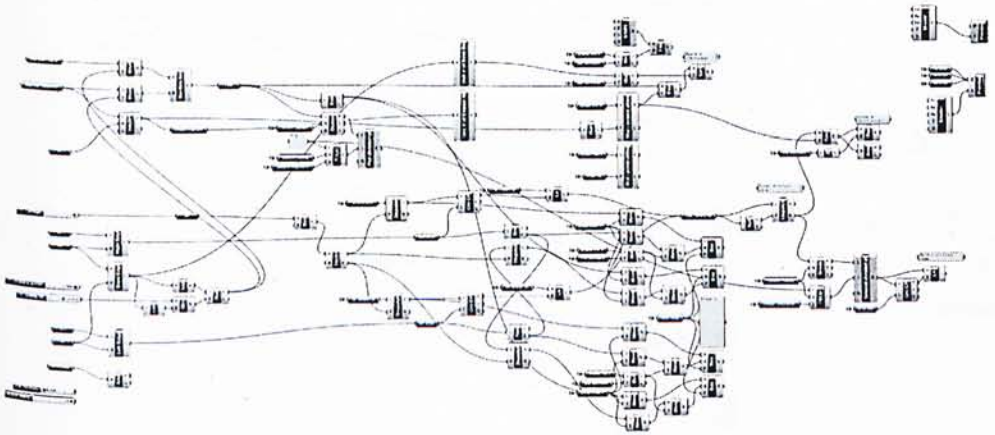


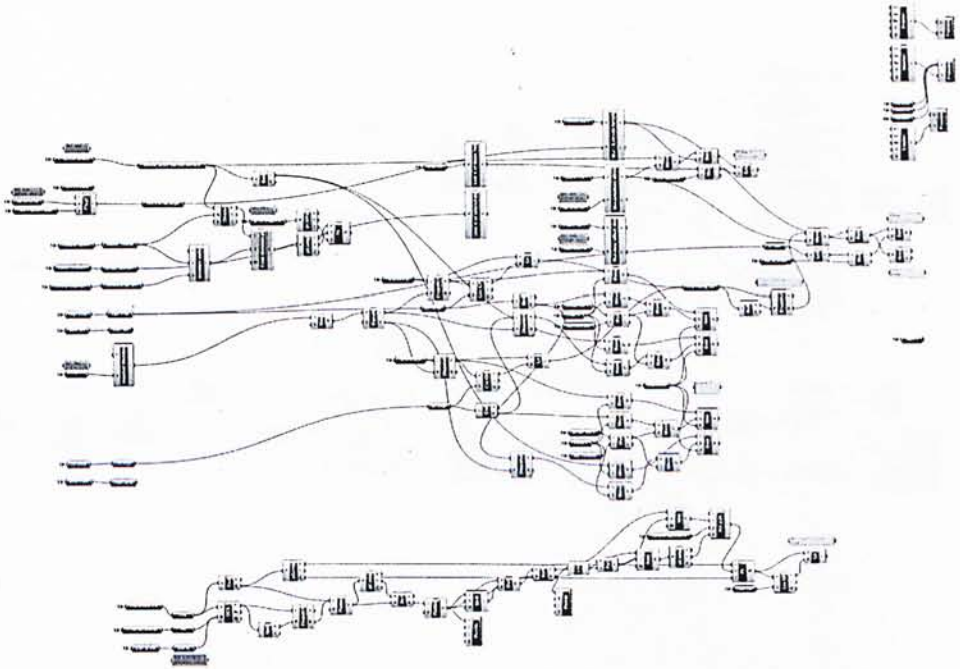
\\Grasshopper Scripts
Massing Manipulation



\\Grasshopper Scripts

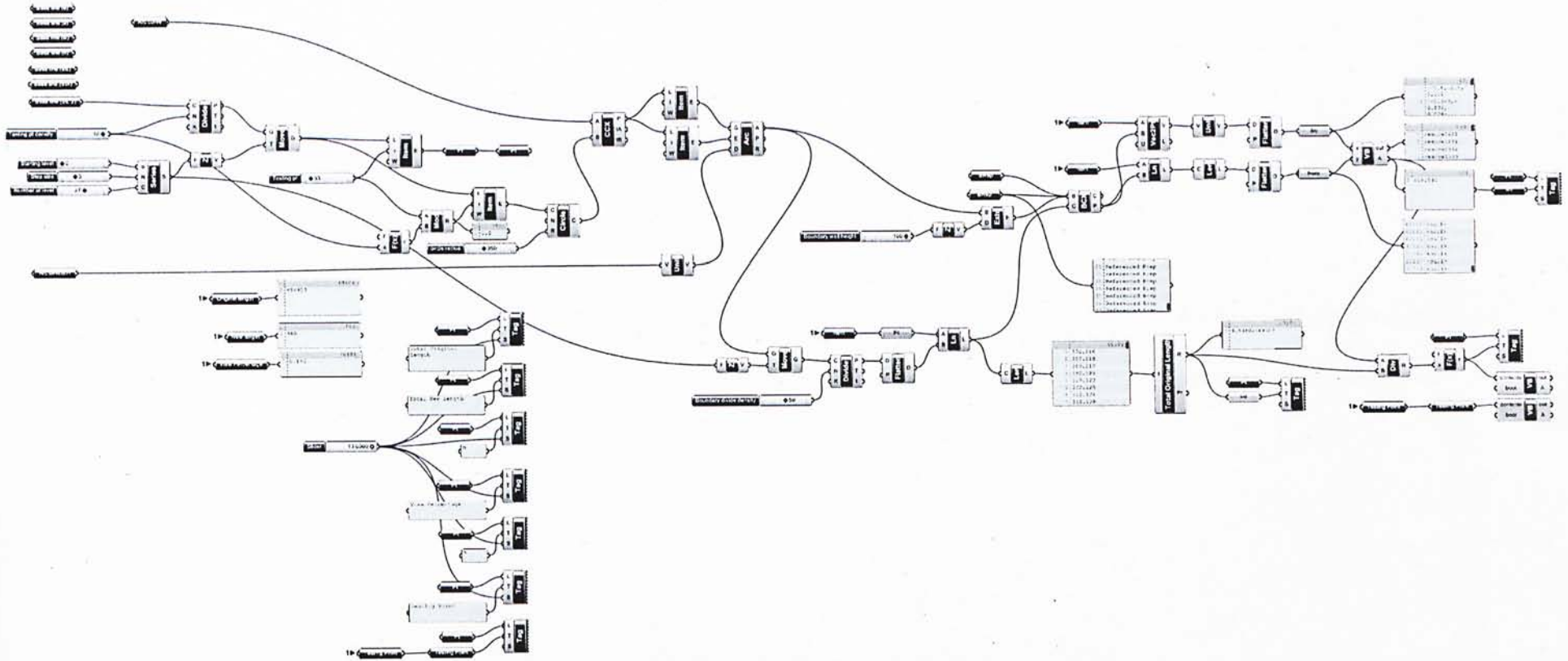
Differentiation (Partial)





\\Grasshopper Scripts

View Opennes Calculation



Acknowledgment

Thesis Advisor : Nelson Tam Sin-Lung
THANKYOU for your guidance and honesty

Part III

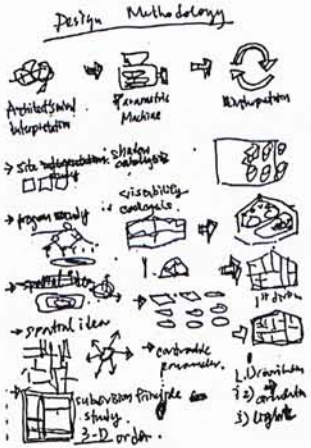
flip book . process & methodology

School of Architecture . The Chinese University of Hong Kong . Thesis Report . WONG Chui-kwan Alice . 2009 - 2010

Parametric Variation in Architecture

Special Study . Documentary of Design Making

This is a flip book of a movie clip to review the design process and methodology.



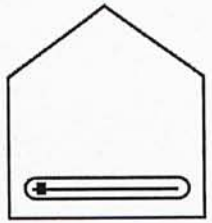
Parametric Variation in Architecture

Special Study . Documentary of Design Making

Design of the Parametric Student House, as a testing ground of "Slider Architecture", is being considered as a dynamic process of negotiation of spaces. Effective way of communication between our human brain and the computational machine is important for such kind of design so that we get to know each role of making at different design stages and how they can actively inform each other to make appropriate decision and finally achieve a coherent and optimized result, within a wide range of variations and possibilities. For the special study, the chance is taken to document the process of making and reflect on the interfacing of the manual and the digital realm. The goal is to review and visualize the dynamic "back-of-house" of parametric design to the general public with animated pictures.

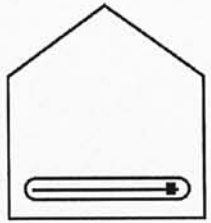
Parametric Variation in Architecture

from designing parameters to parametric design



Architectural Project

Parametric House

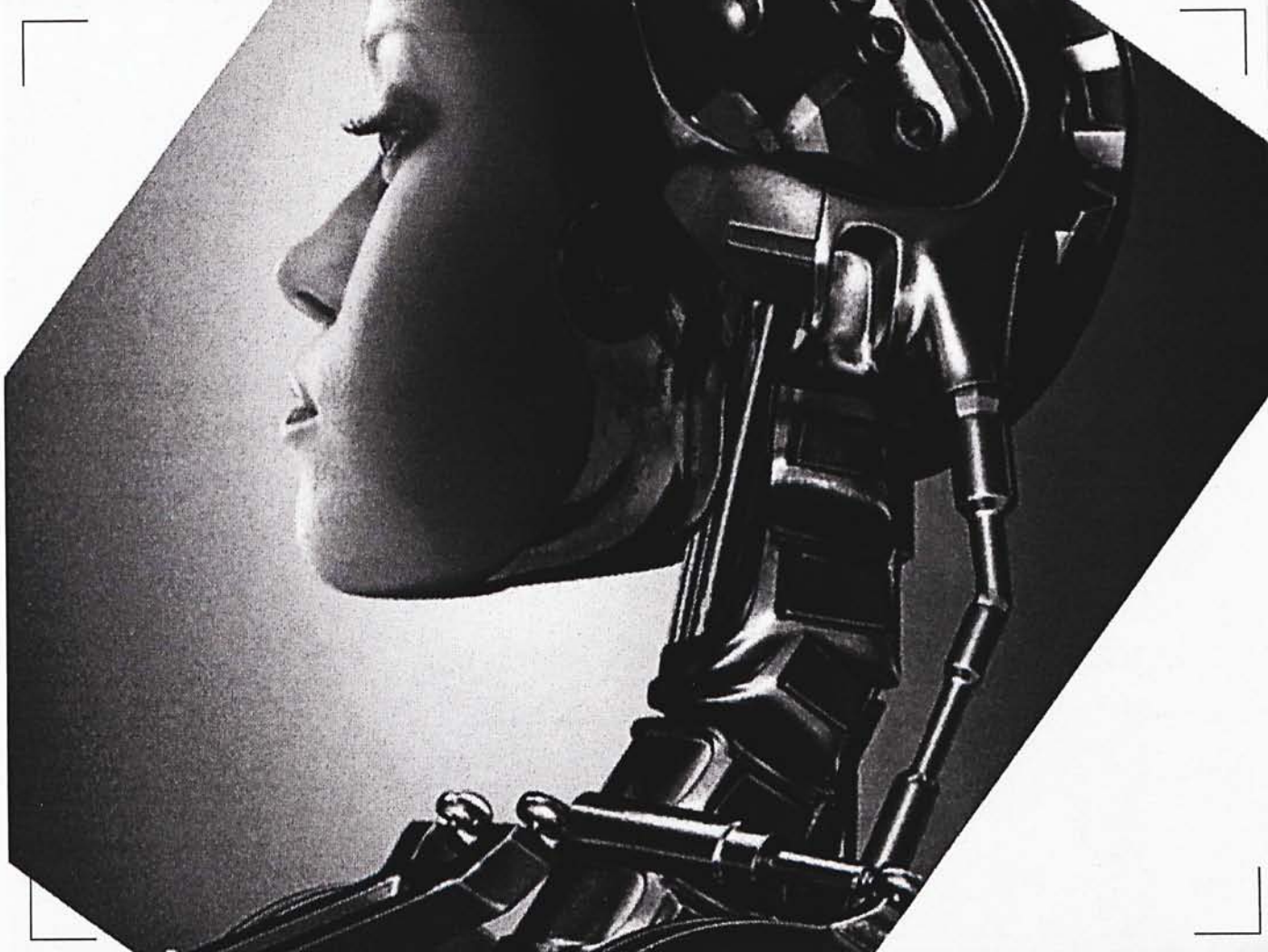


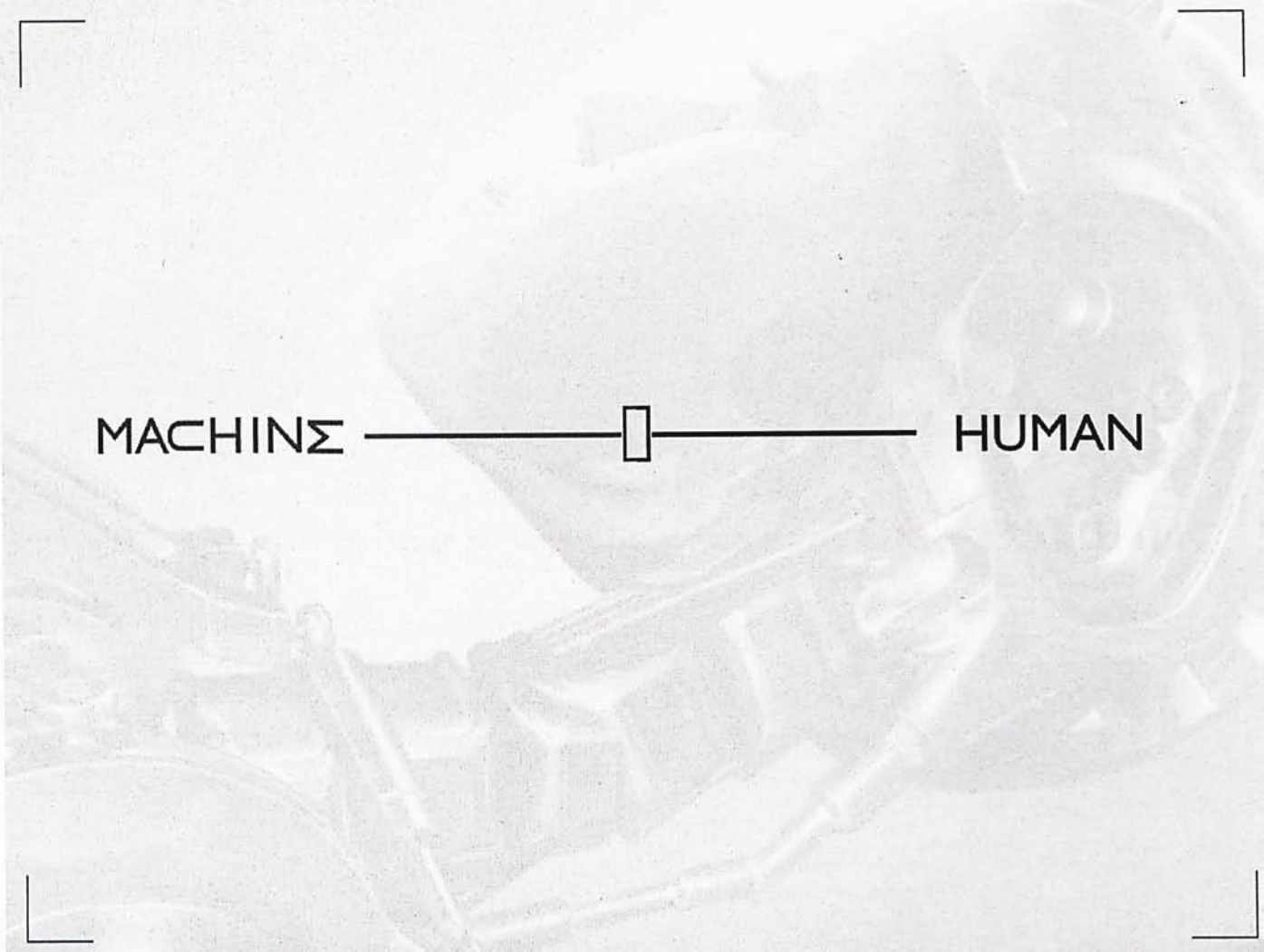
Architectural Project

Parametric House

Special Study

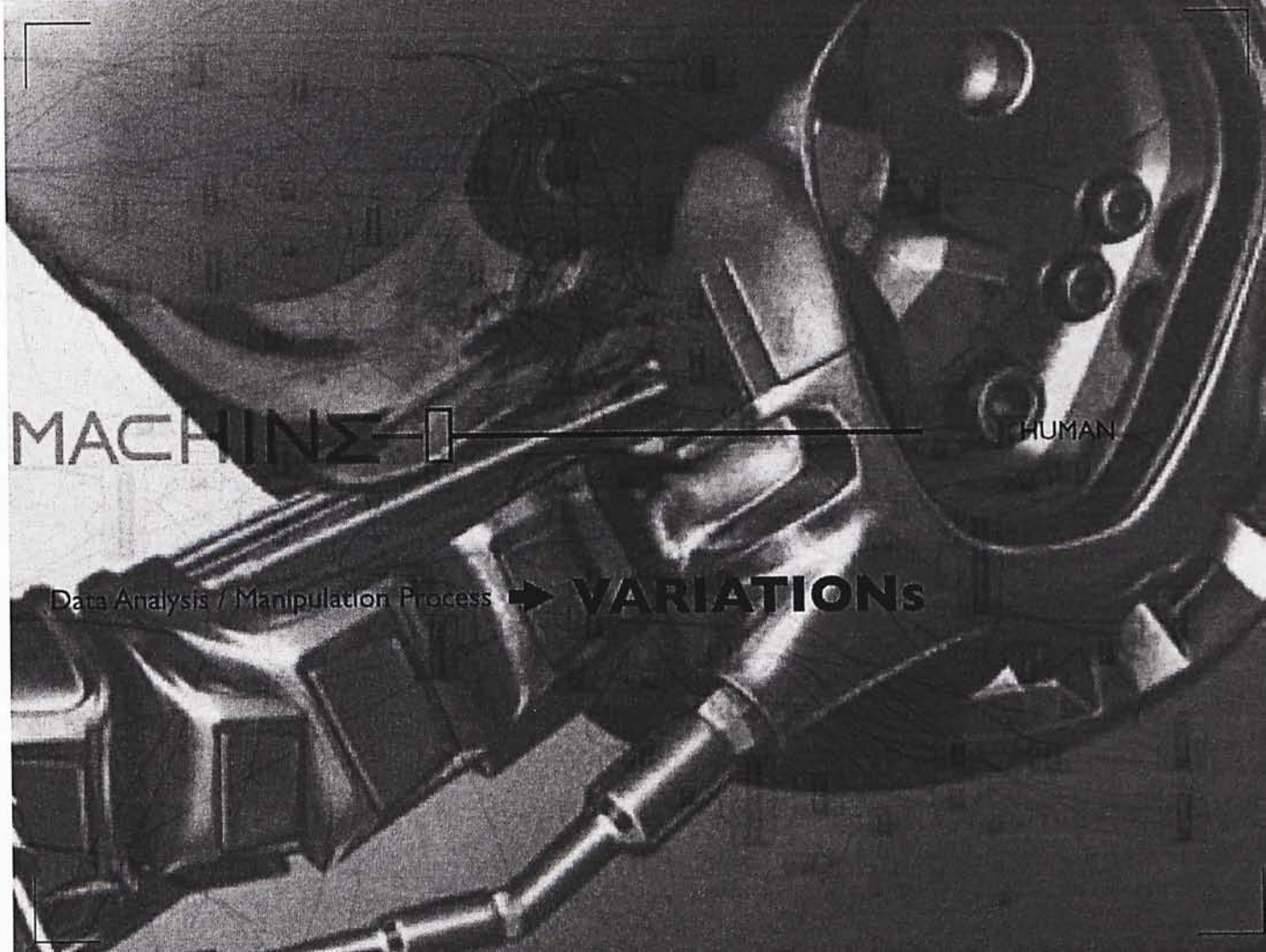
Documentary of Design Making

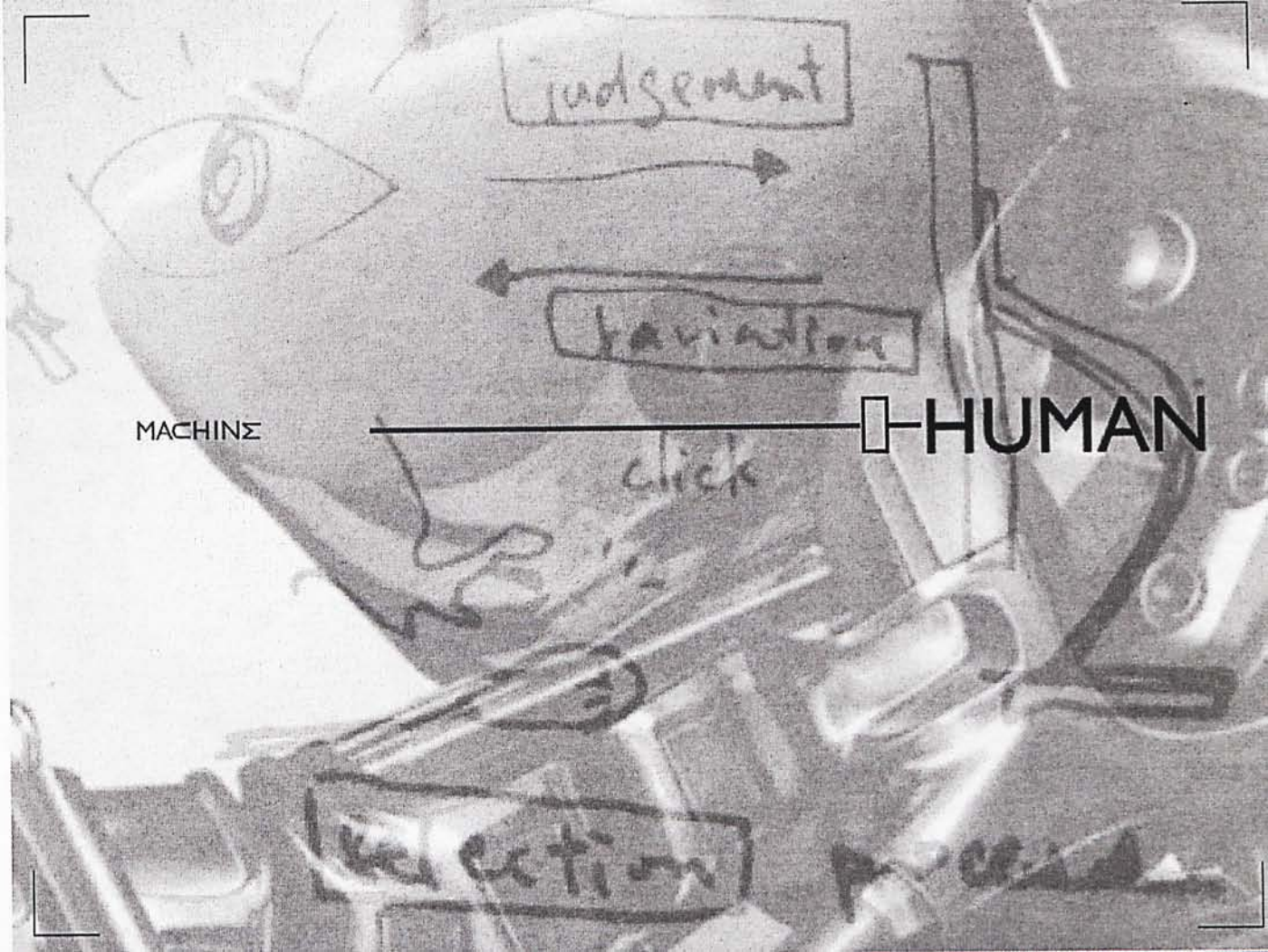


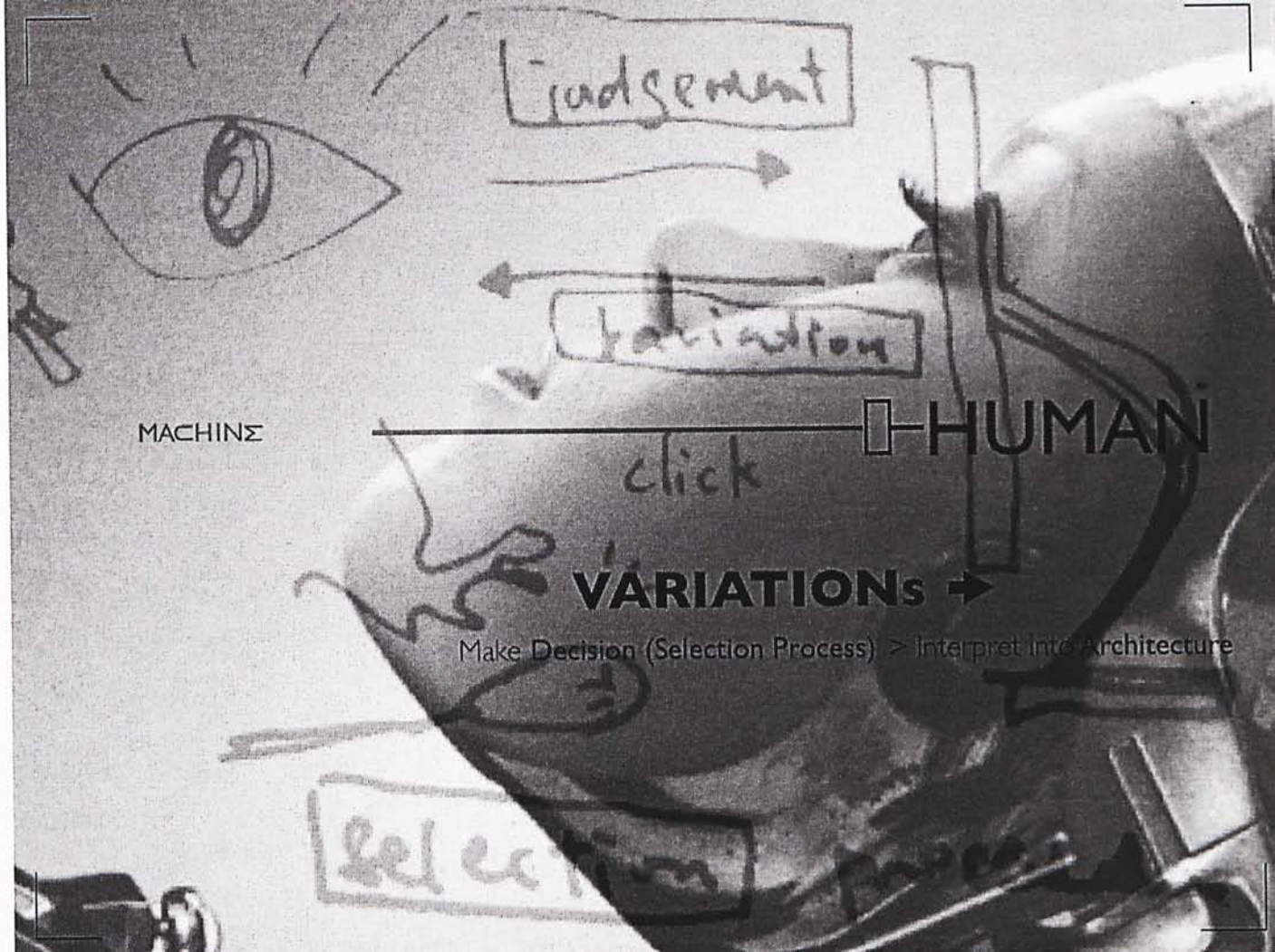

MACHINΣ
HUMAN

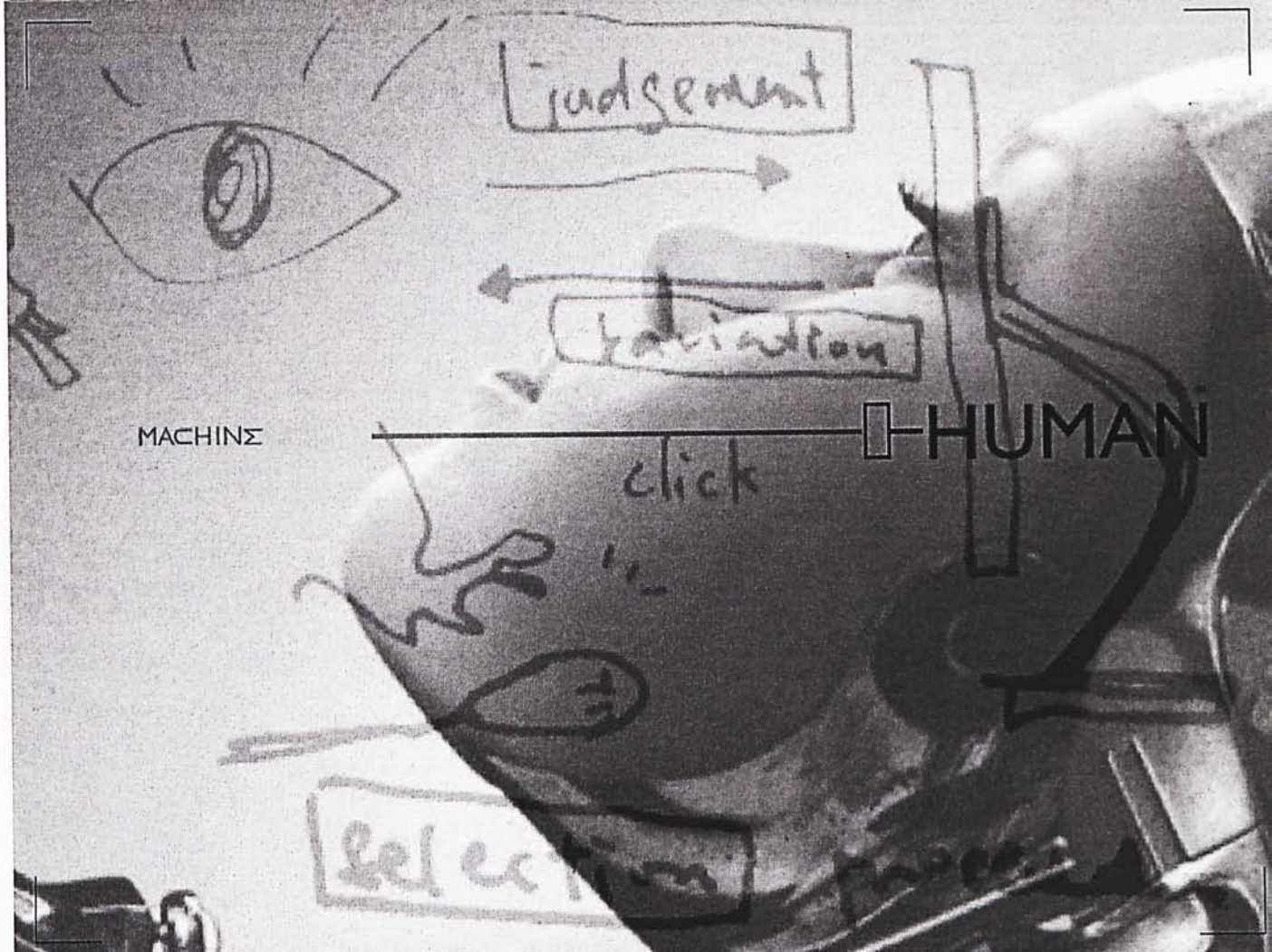
MACHINΣ —— HUMAN

Define **Design Factors** > Define **Parameters** > Design MACHINΣ


MACHINE
HUMAN
Data Analysis / Manipulation Process
VARIATIONs


judgement
MACHINE
HUMAN


judgement
click
MACHINE
HUMAN
VARIATIONs
Make Decision (Selection Process) > Interpret Into Architecture


judgement
click
MACHINE
HUMAN

MACHINΣ

HUMAN

site condition

+ Urban Visibility
+ Urabn Accessibility
+ Urban Publicity
+ Shadow


Hung Hom

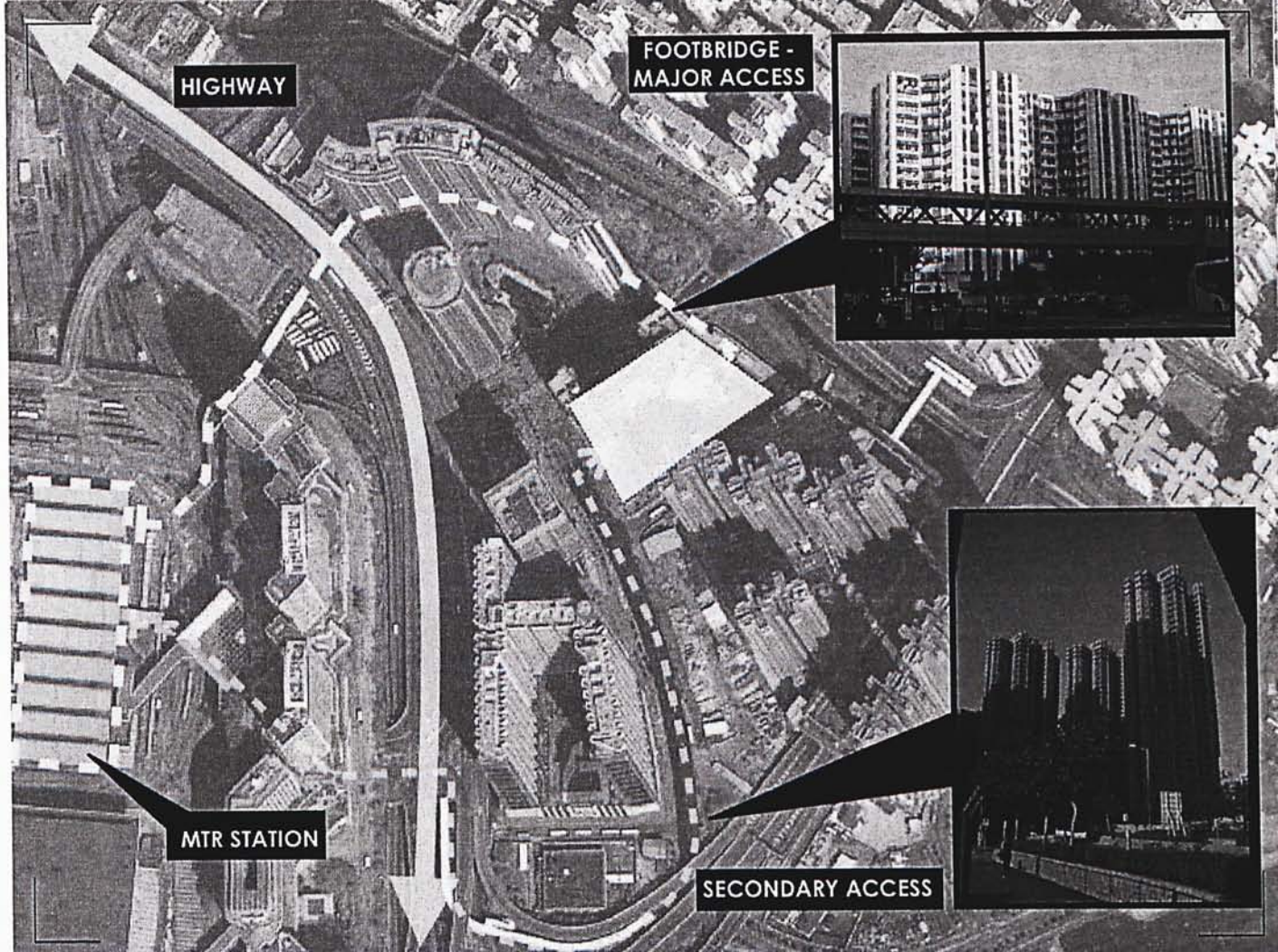

Hung Hom

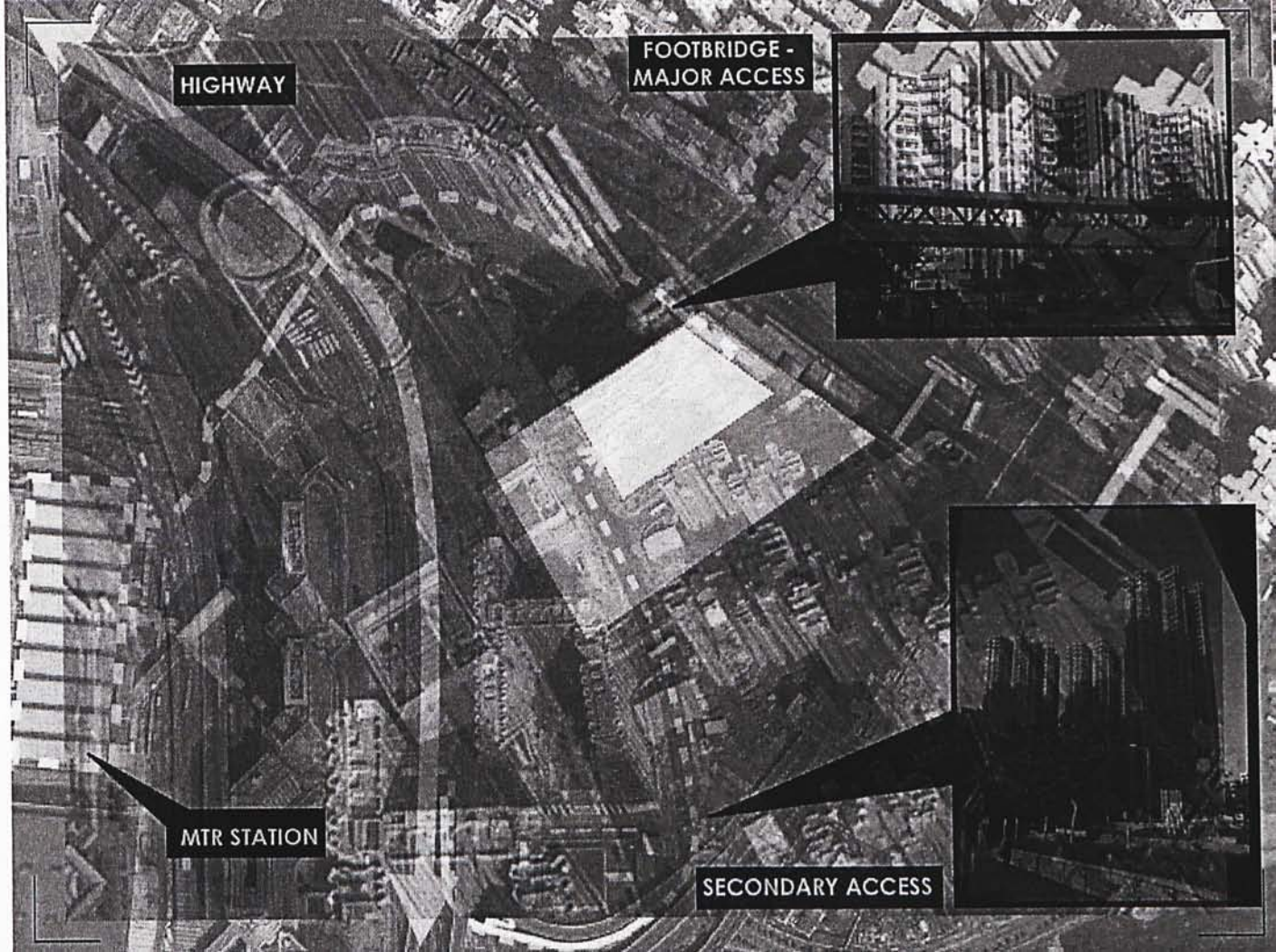

?
Hung Hom

Variety of VIEWING QUALITY

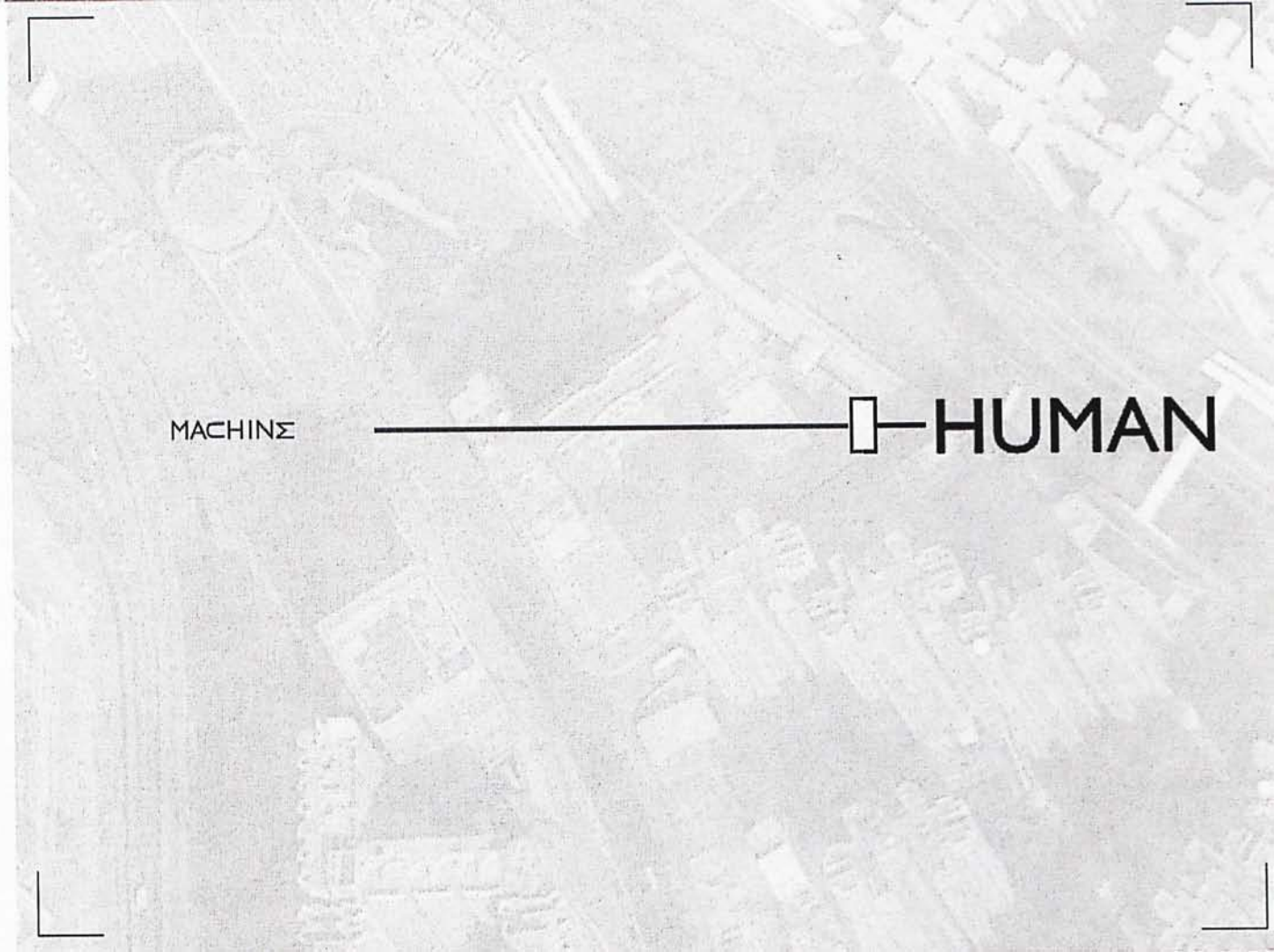

Variety of VIEWING QUALITY


HIGHWAY
MTR STATION


HIGHWAY
FOOTBRIDGE - MAJOR ACCESS
MTR STATION
SECONDARY ACCESS


HIGHWAY
FOOTBRIDGE - MAJOR ACCESS
MTR STATION
SECONDARY ACCESS

Urban Green Belt
BRIDGING POINT
Urban Green Belt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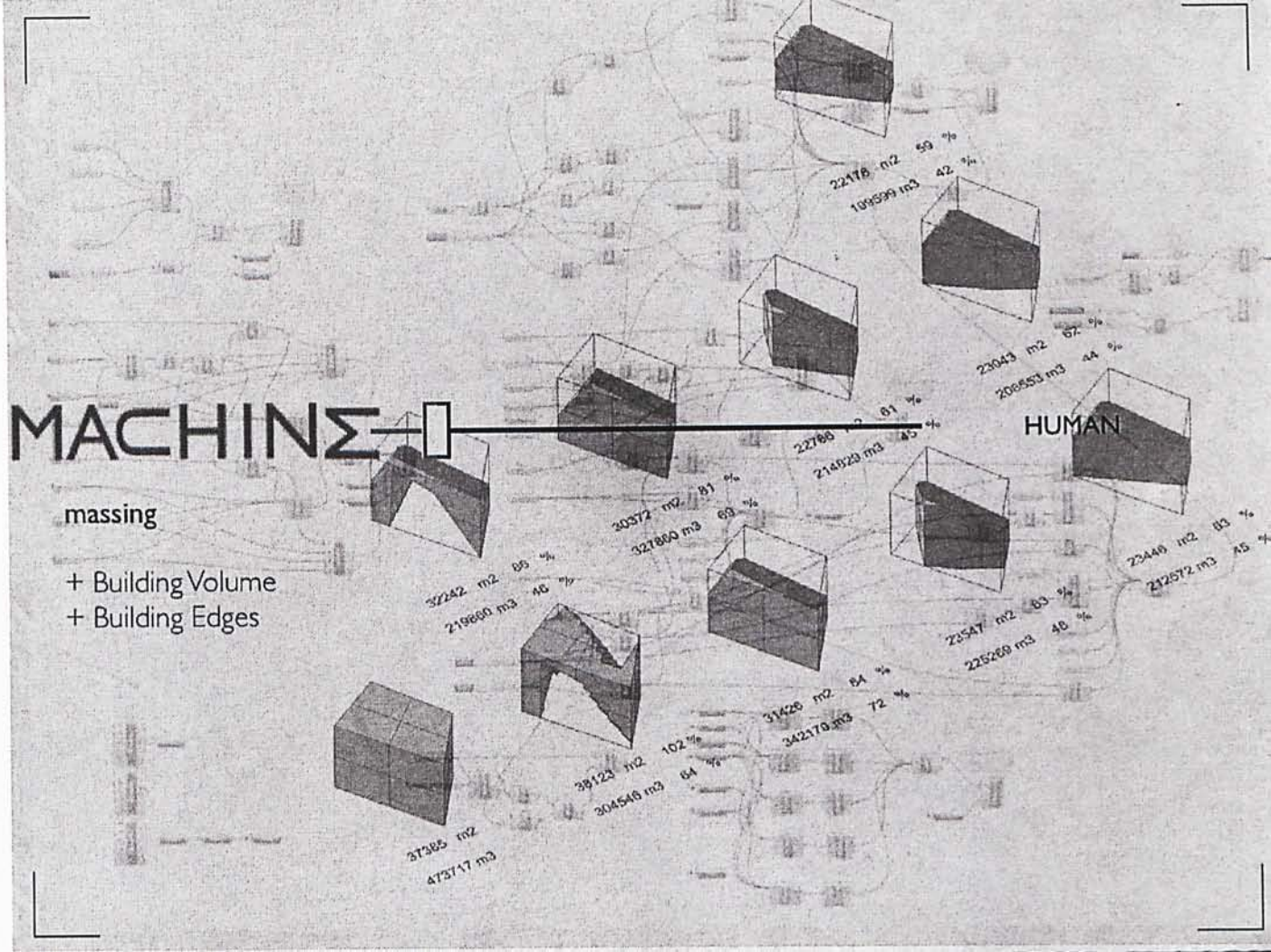
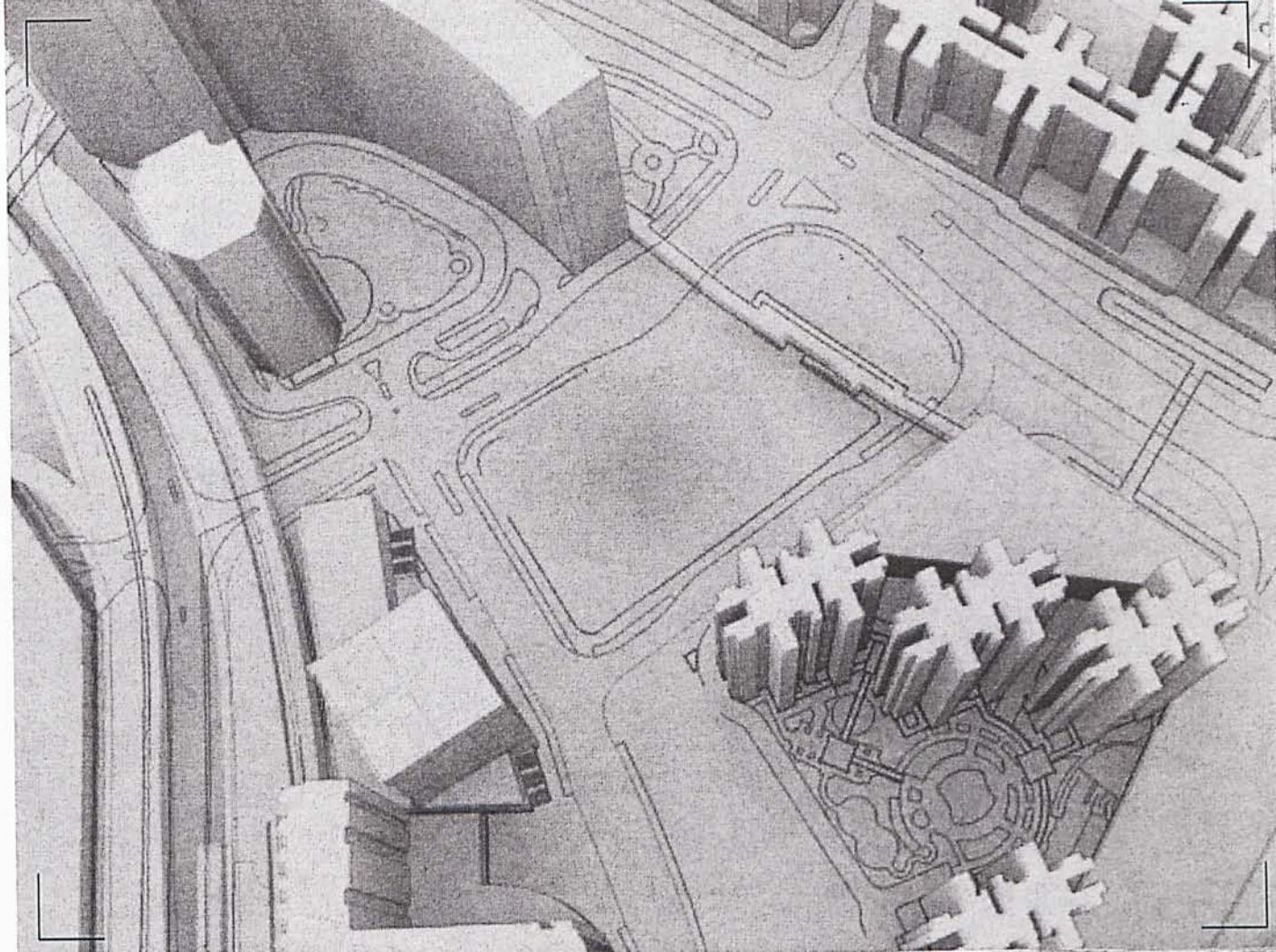
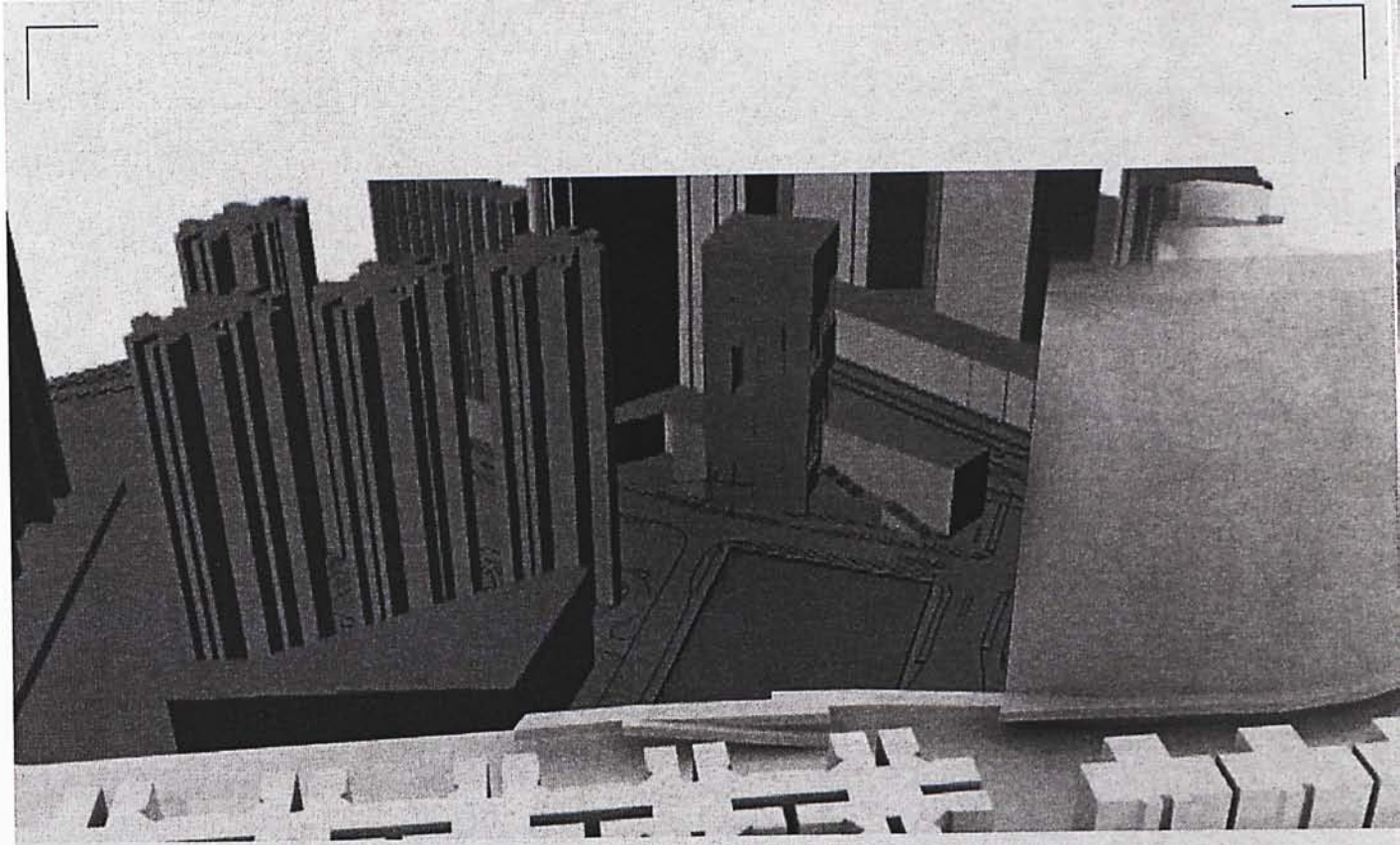

MACHINE
HUMAN
massing
+ Building Volume
+ Building Edges
22178 m2 59 %
109599 m3 42 %
23043 m2 67 %
206853 m3 44 %
22788 m2 81 %
214820 m3 45 %
23446 m2 83 %
212572 m3 45 %
30372 m2 81 %
321860 m3 69 %
32242 m2 85 %
219660 m3 46 %
23547 m2 83 %
225269 m3 48 %
31426 m2 84 %
342170 m3 72 %
38123 m2 102 %
304546 m3 64 %
37385 m2
473717 m3



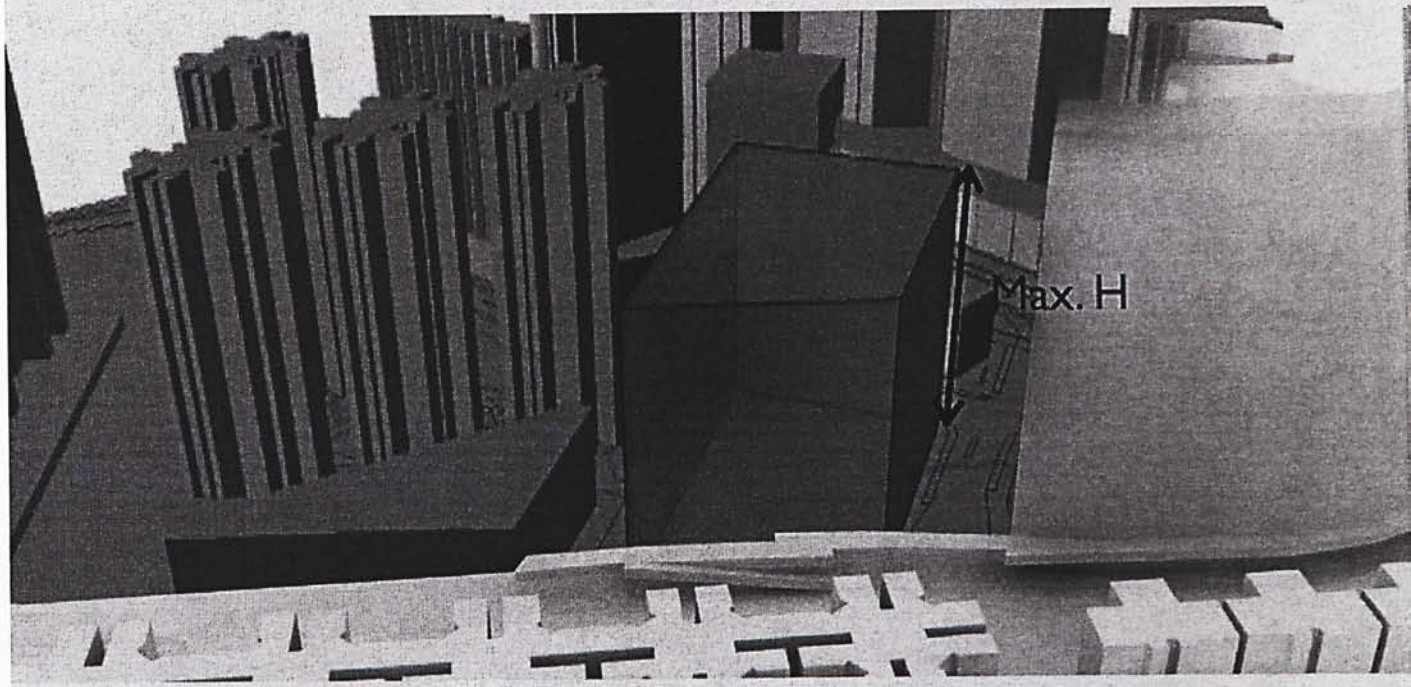


massing

Extruding building volume - Max. Height, Max Volume

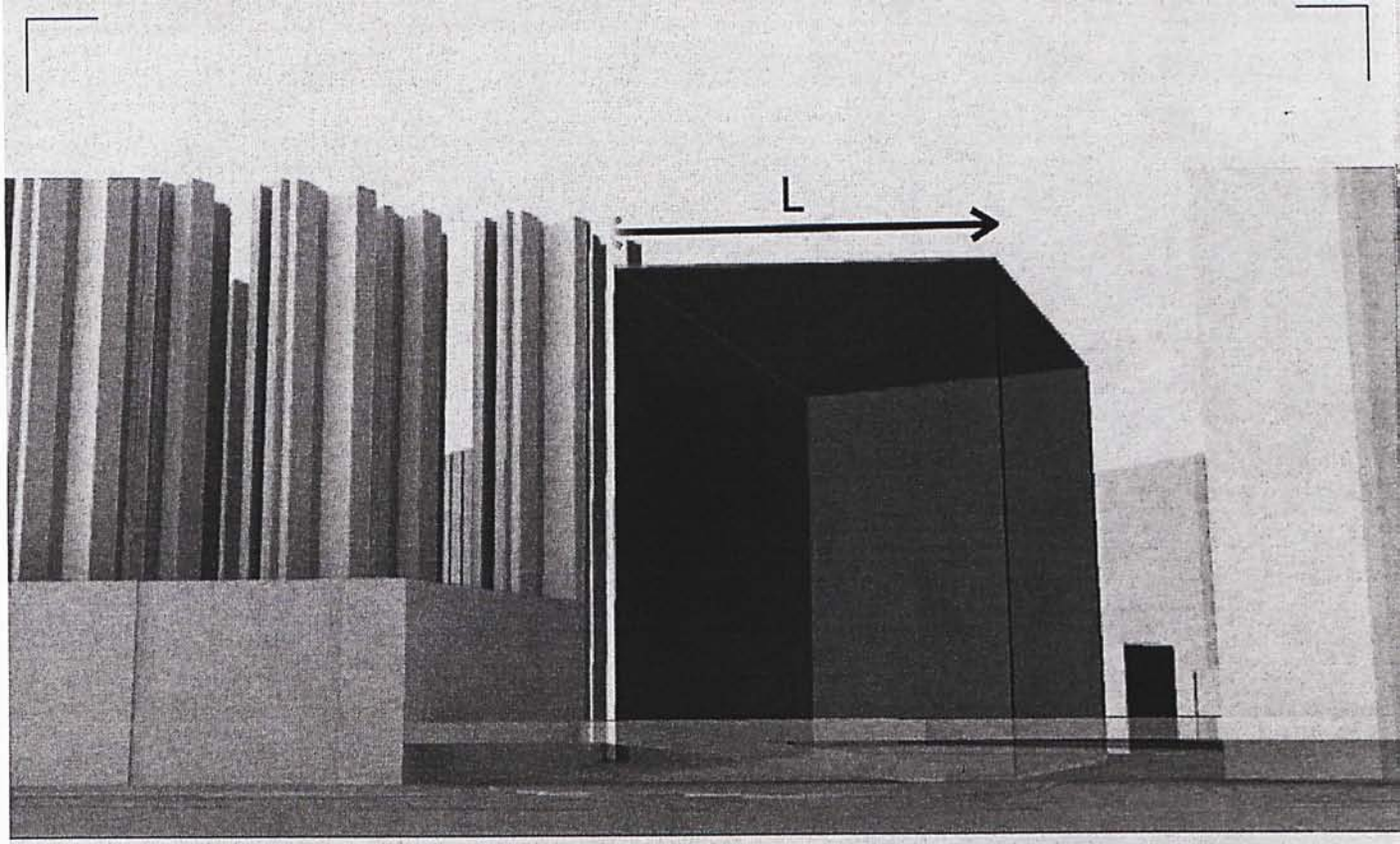
massing

Extruding building volume - Max. Height, Max Volume



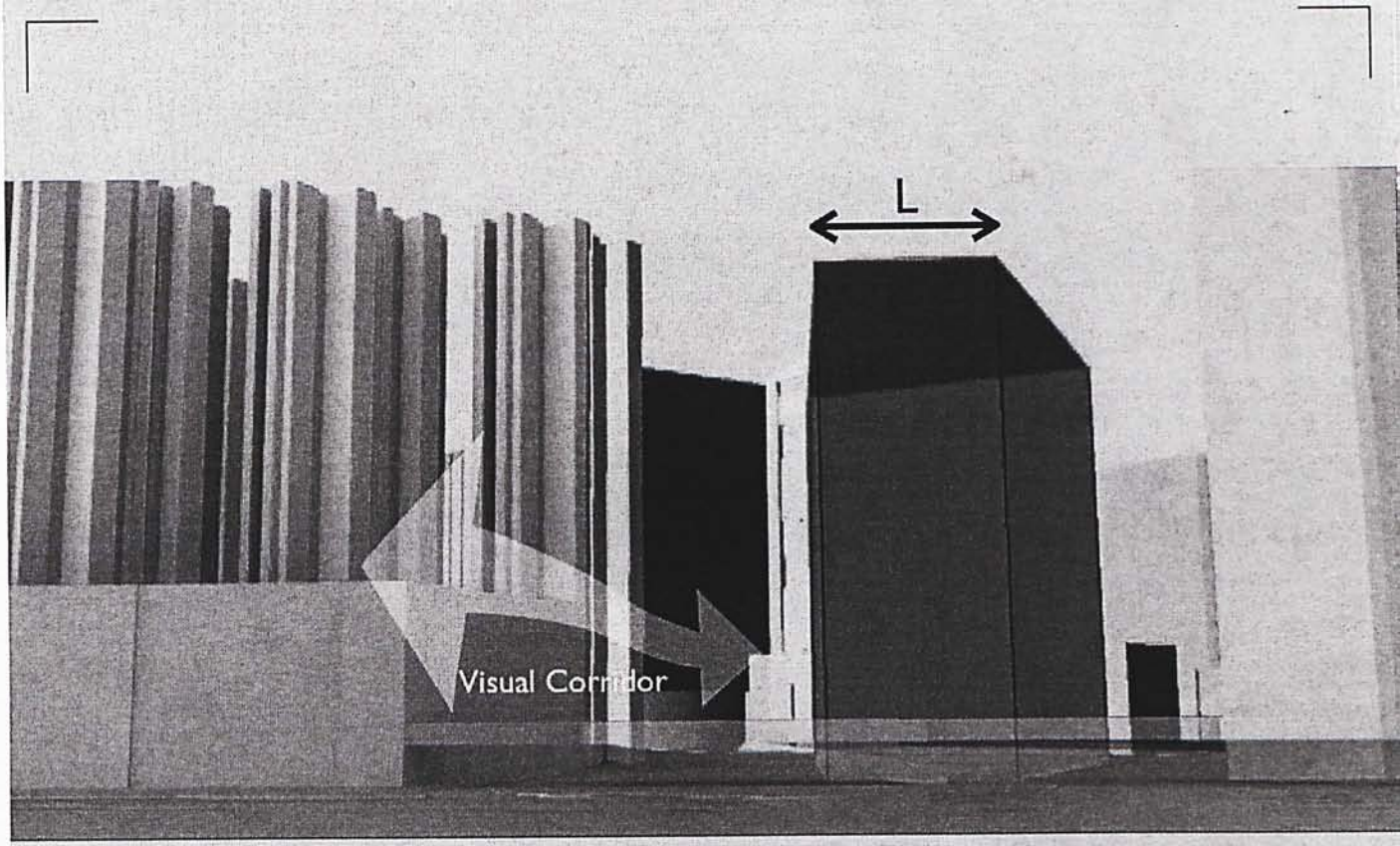
massing

Extruding building volume - Max. Height, Max Volume



Visual Connectivity

Reducing the width to create set back from adjacent estate



Visual Connectivity

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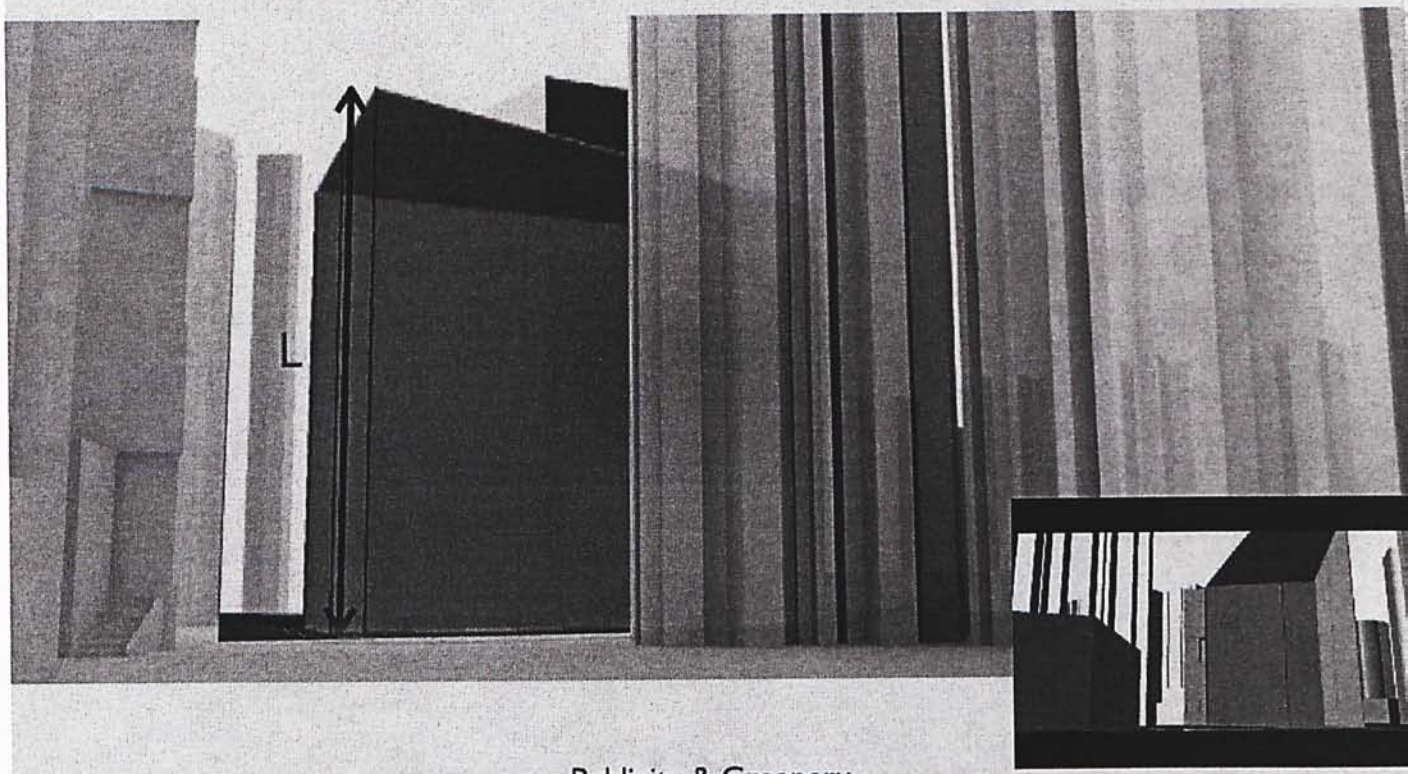
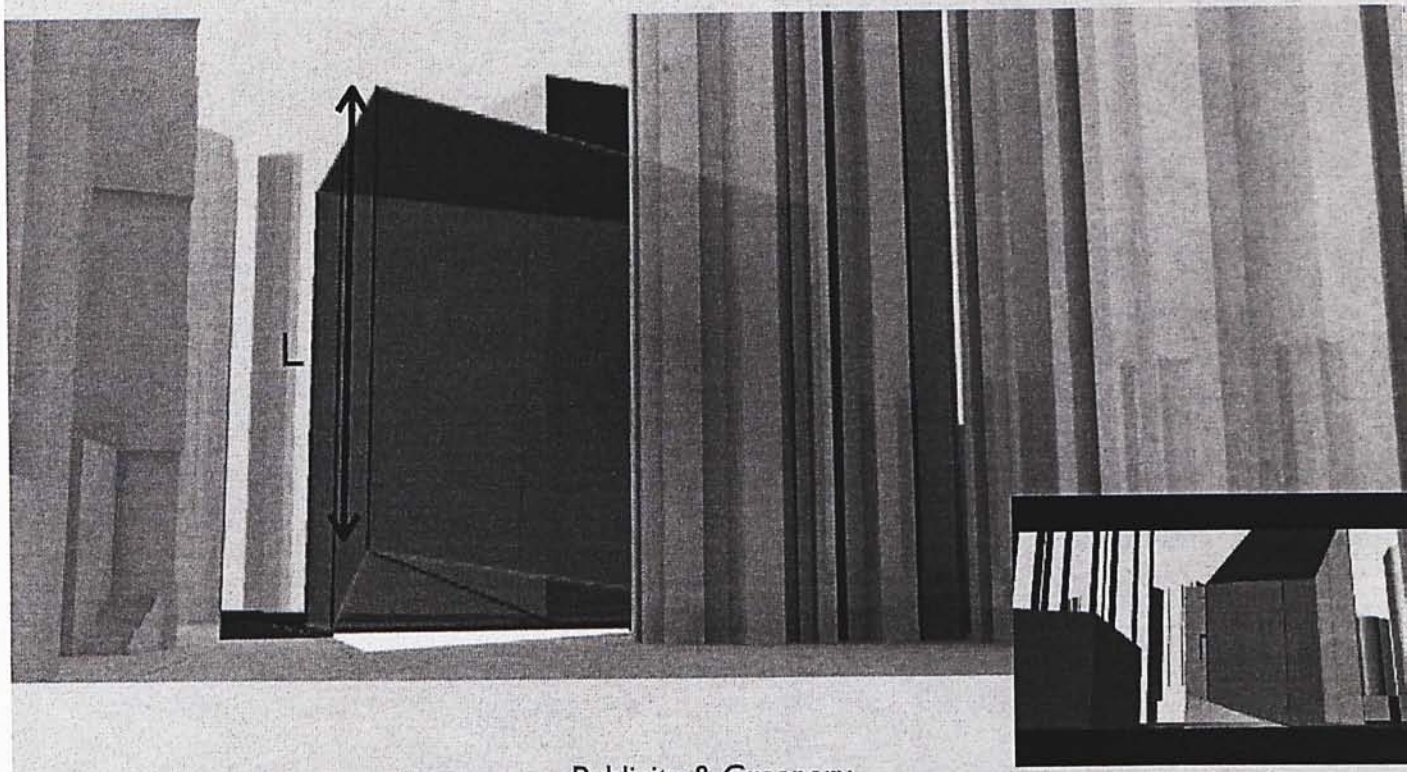


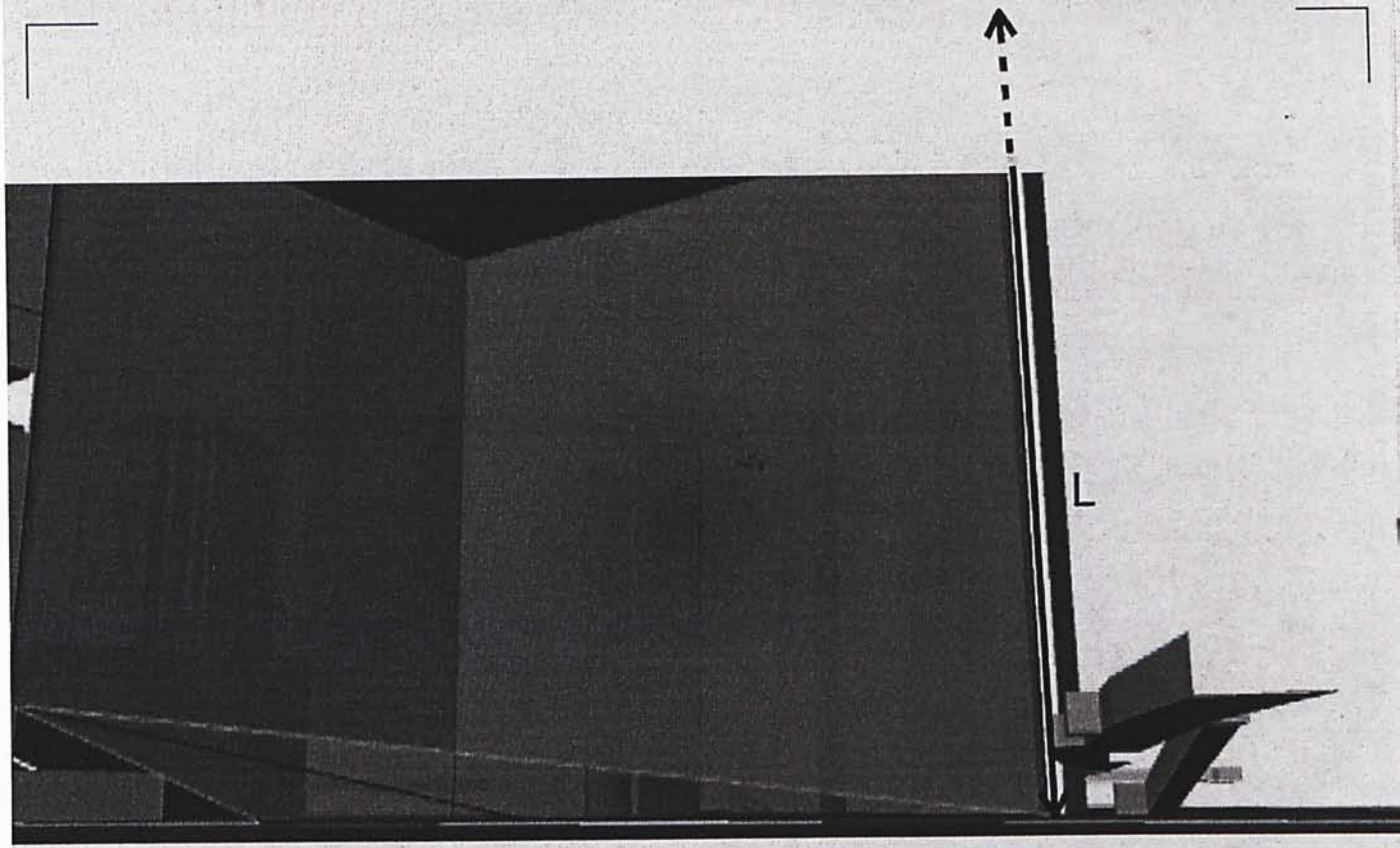
Publicity & Greenery

Reducing building Height from ground to create wider setback

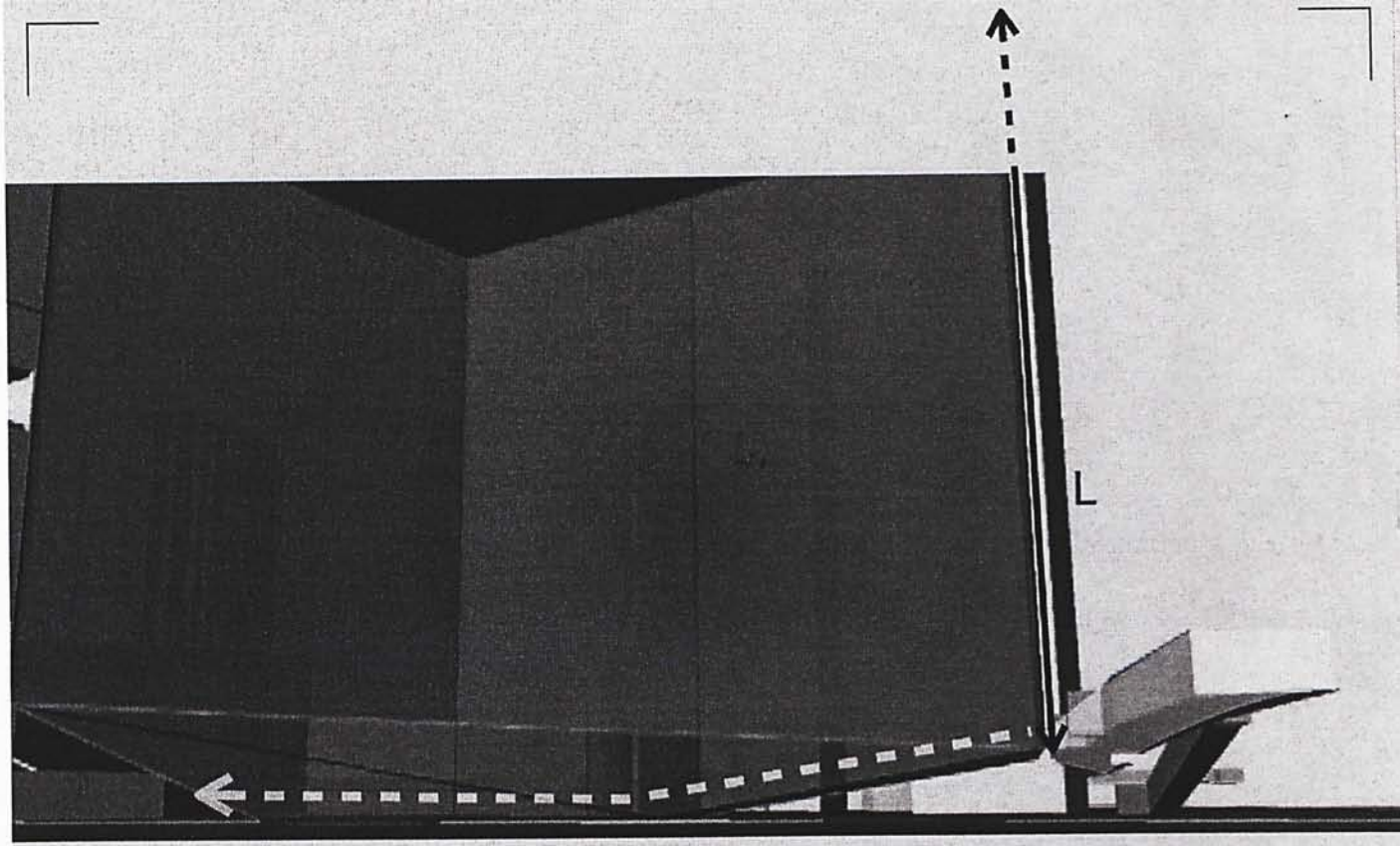


Publicity & Greenery

Reducing building Height from ground to create wider setback

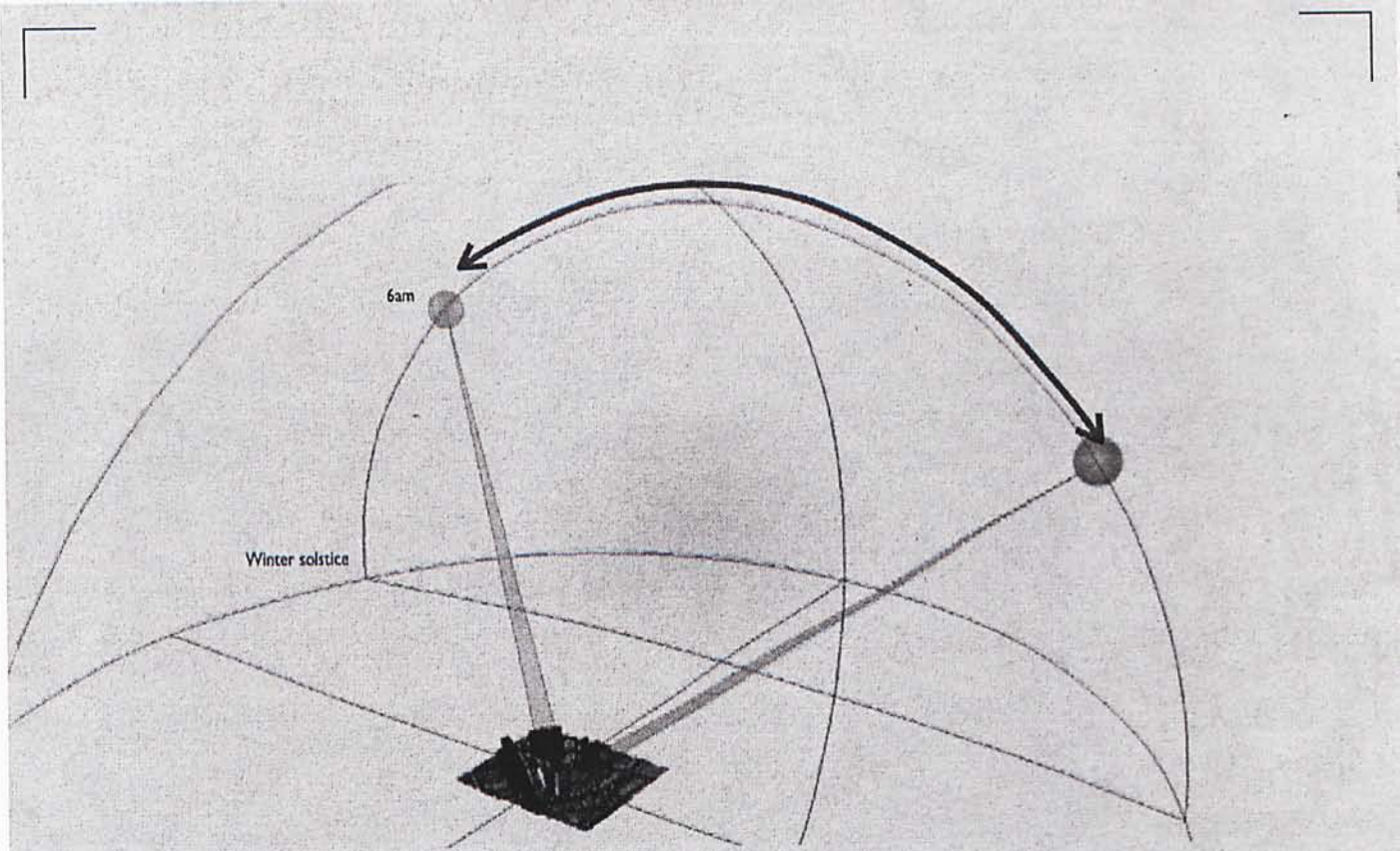


Accessibility



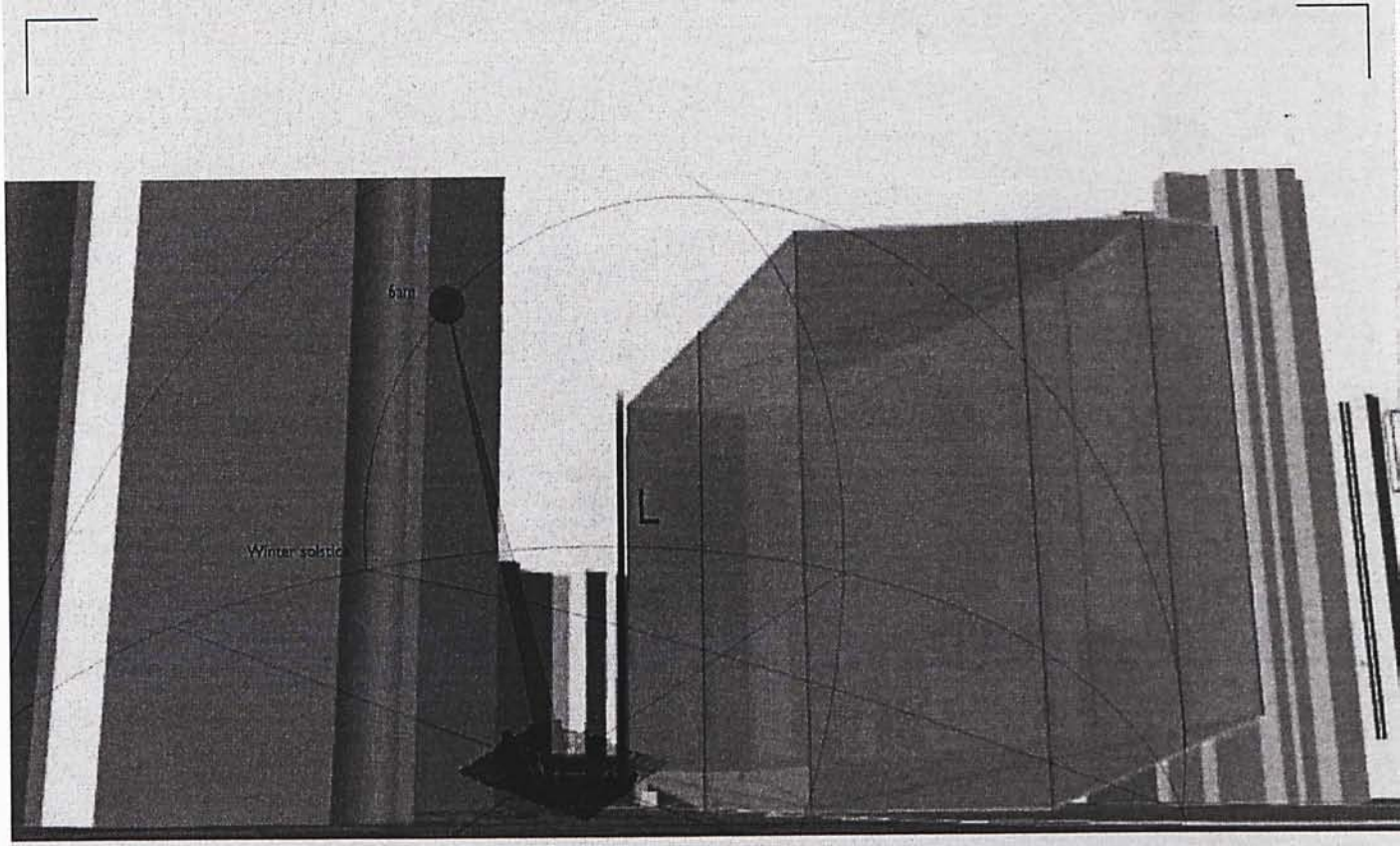
Accessibility

connecting entry point to footbridge



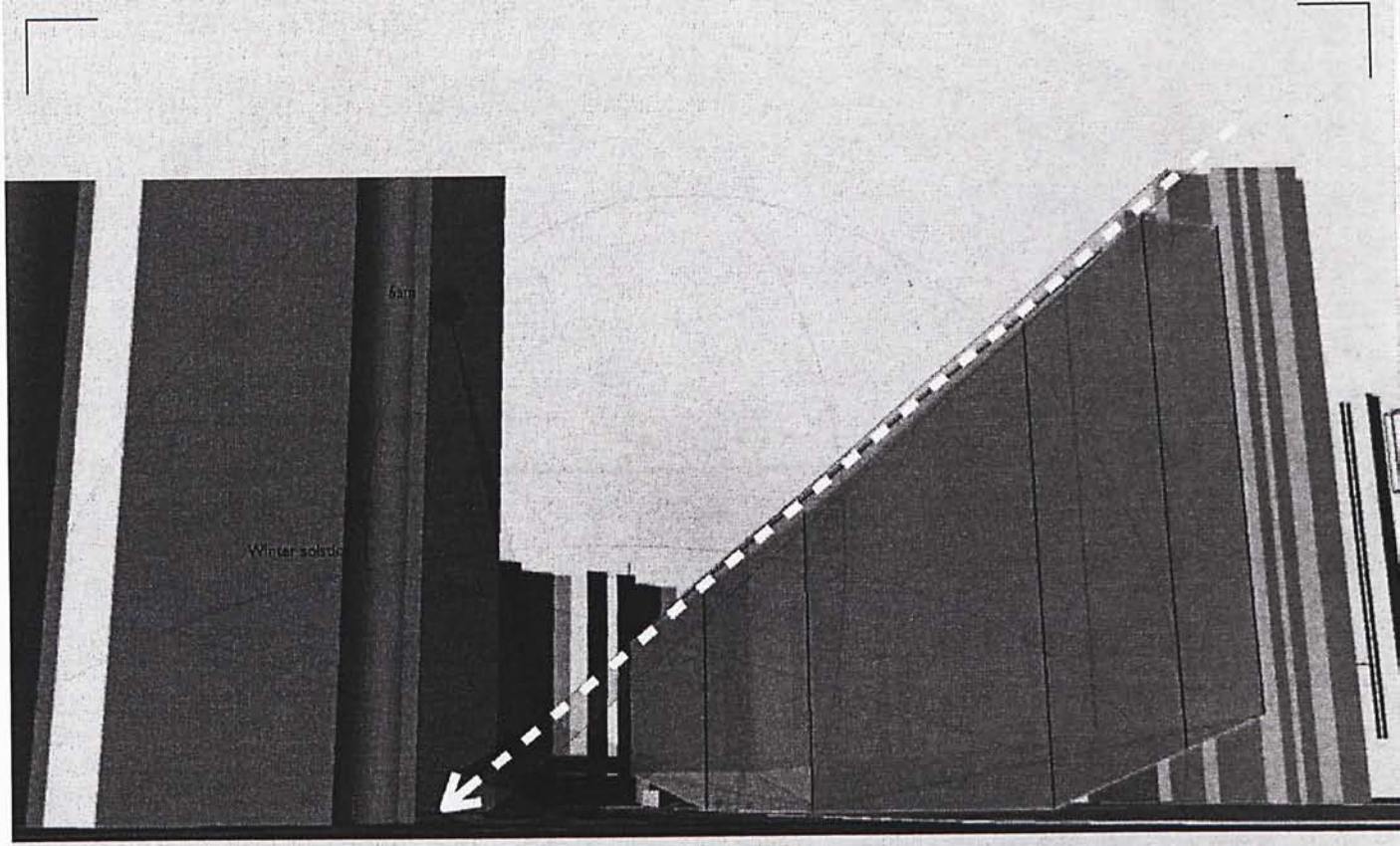
Shadow Casting

Minimizing shadow casted on adjacent buildings in winter time



Shadow Casting

Minimizing shadow casted on adjacent buildings in winter time



Shadow Casting

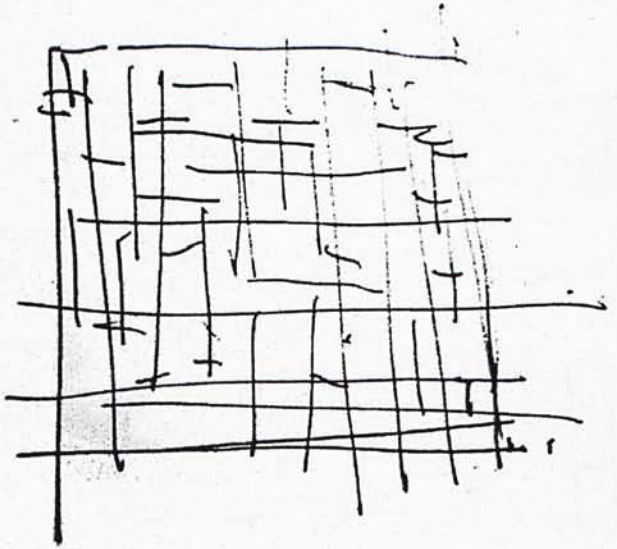
Minimizing shadow casted on adjacent buildings in winter time

MACHINΣ

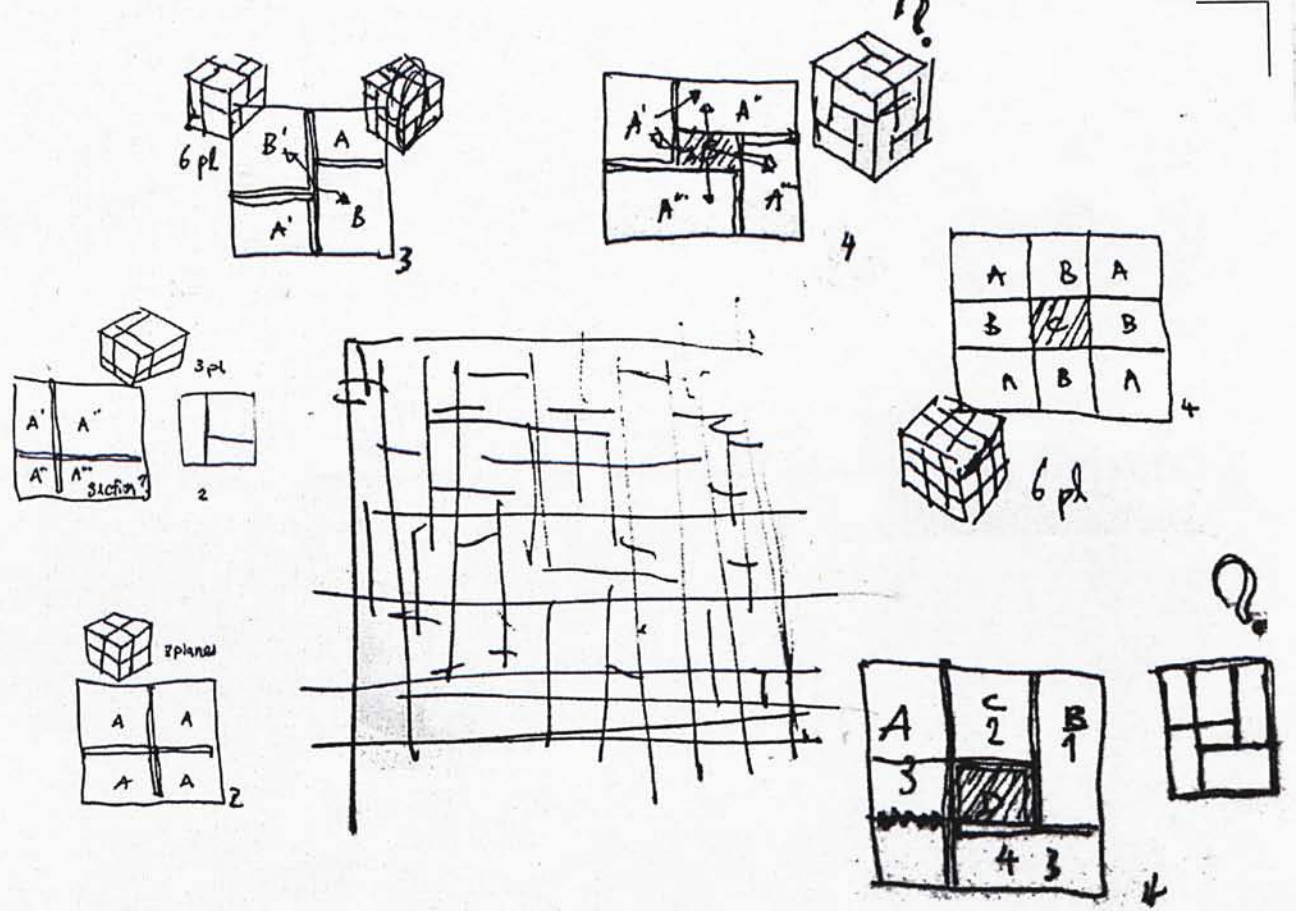
HUMAN

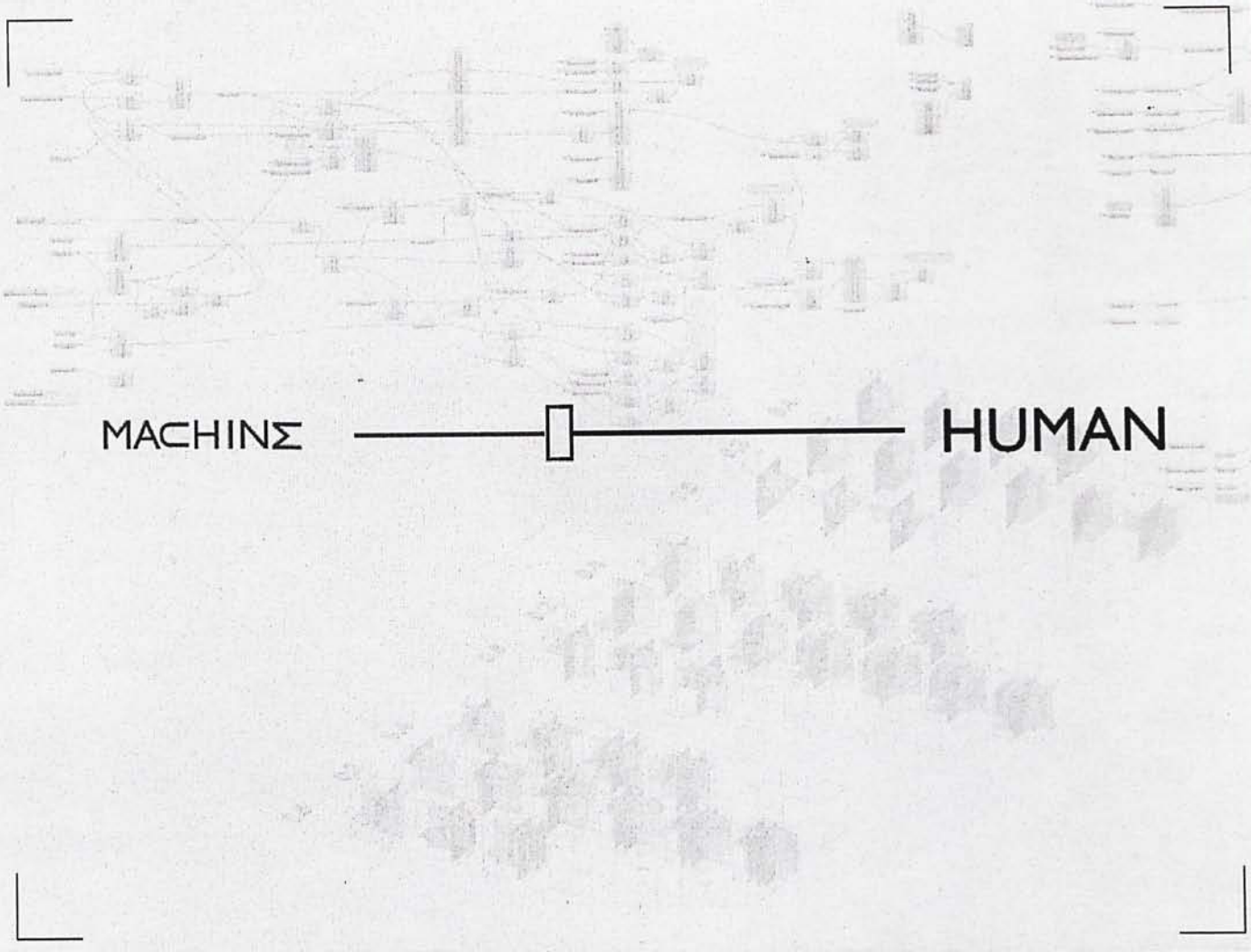
spatial subdivision principl

+ Spatial Organization



Spatial Organization


6 pl
B'
A
B
A'
3
A'
A''
A'''
A''''
4
A
B
A
B
B
A
B
A
4
6 pl
3 pl
A'
A''
A'''
A''''
section ?
2
2 planes
A
A
A
A
2
?
A
3
C
2
B
1
4 3
4

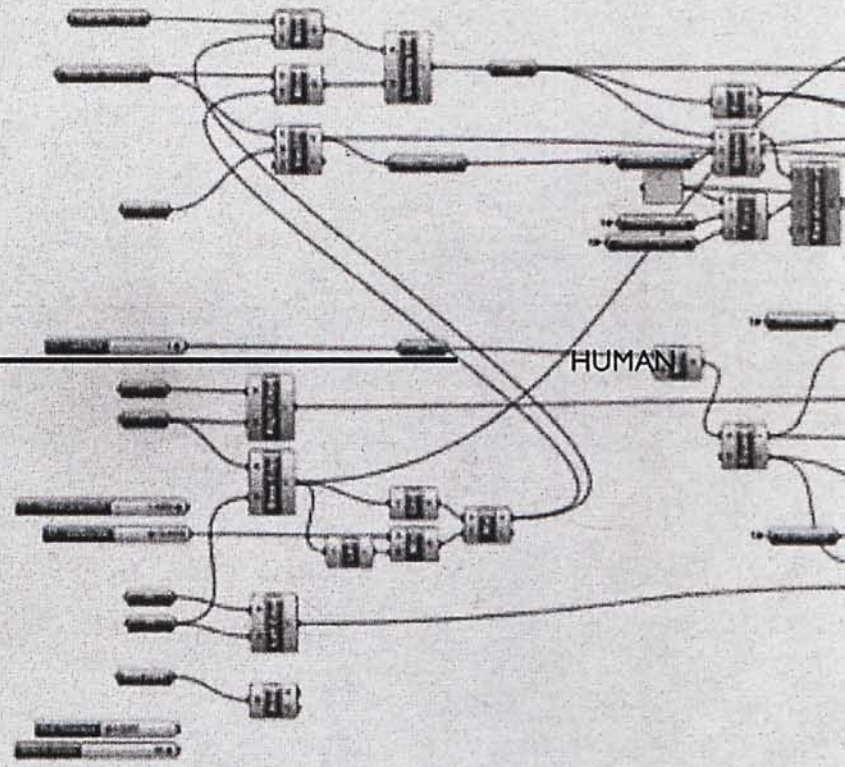

MACHINΣ
HUMAN

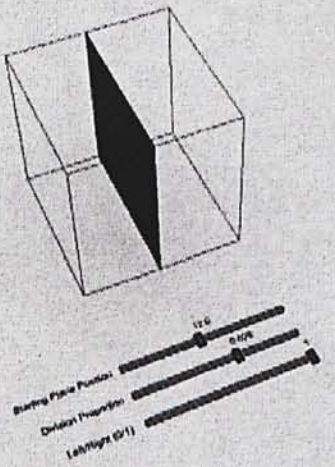
MACHINE

HUMAN

variable parameters

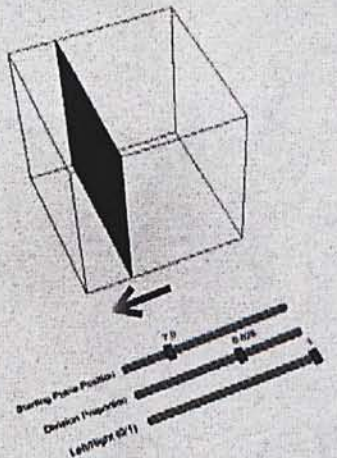
+ Starting Plane Position
+ Spreading Direction
+ Division Proportion





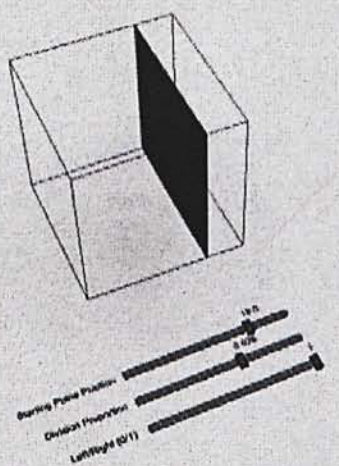
principle variable parameter I

+ Starting Plane Position



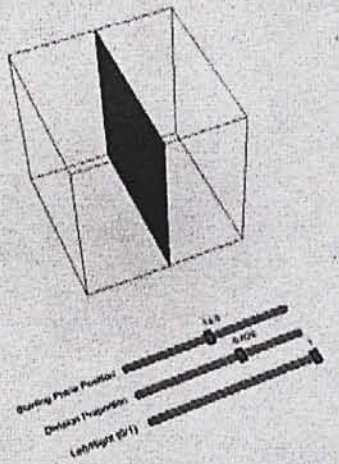
principle variable parameter I

+ Starting Plane Position



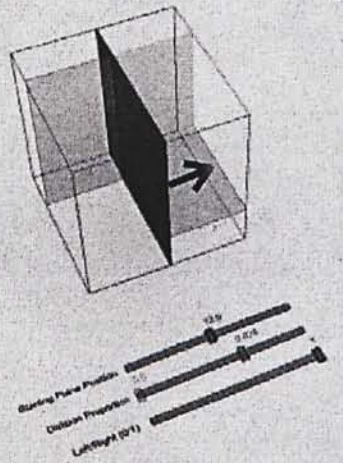
principle variable parameter I

+ Starting Plane Position



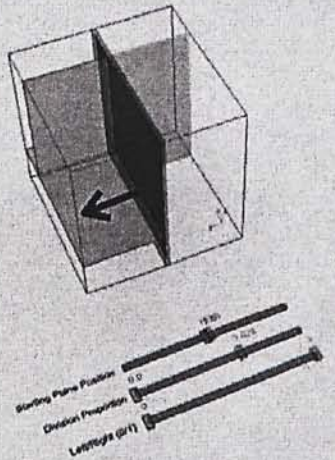
principle variable parameter 2

+ Branching left or right Sequence



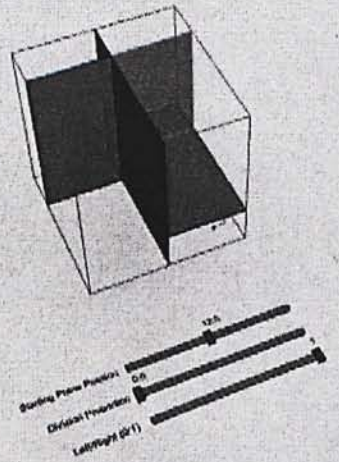
principle variable parameter 2

+ Branching left or right Sequence



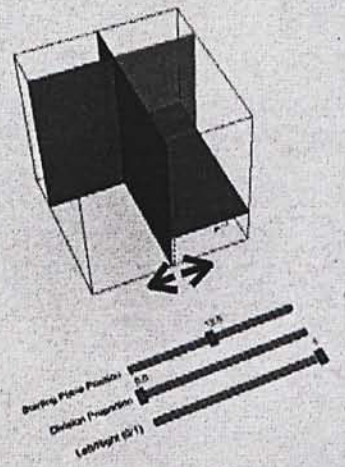
principle variable parameter 2

+ Branching left or right Sequence



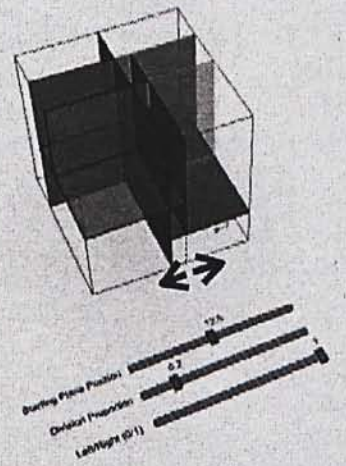
principle variable parameter 3

+ Subdivision Proportion



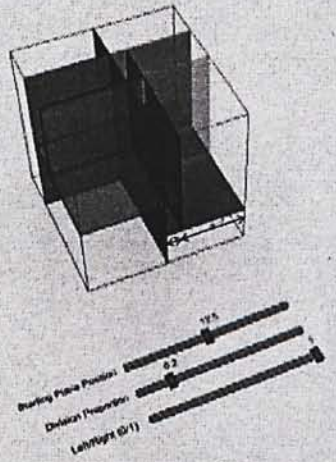
principle variable parameter 3

+ Subdivision Proportion



principle variable parameter 3

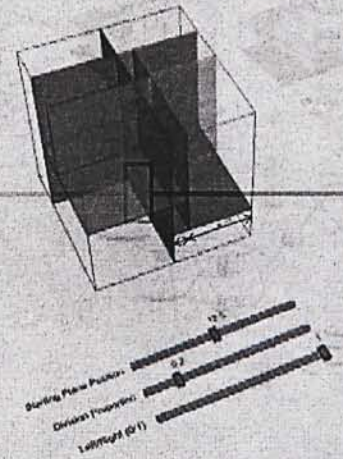
+ Subdivision Proportion



principle variable parameter 3

+ Subdivision Proportion

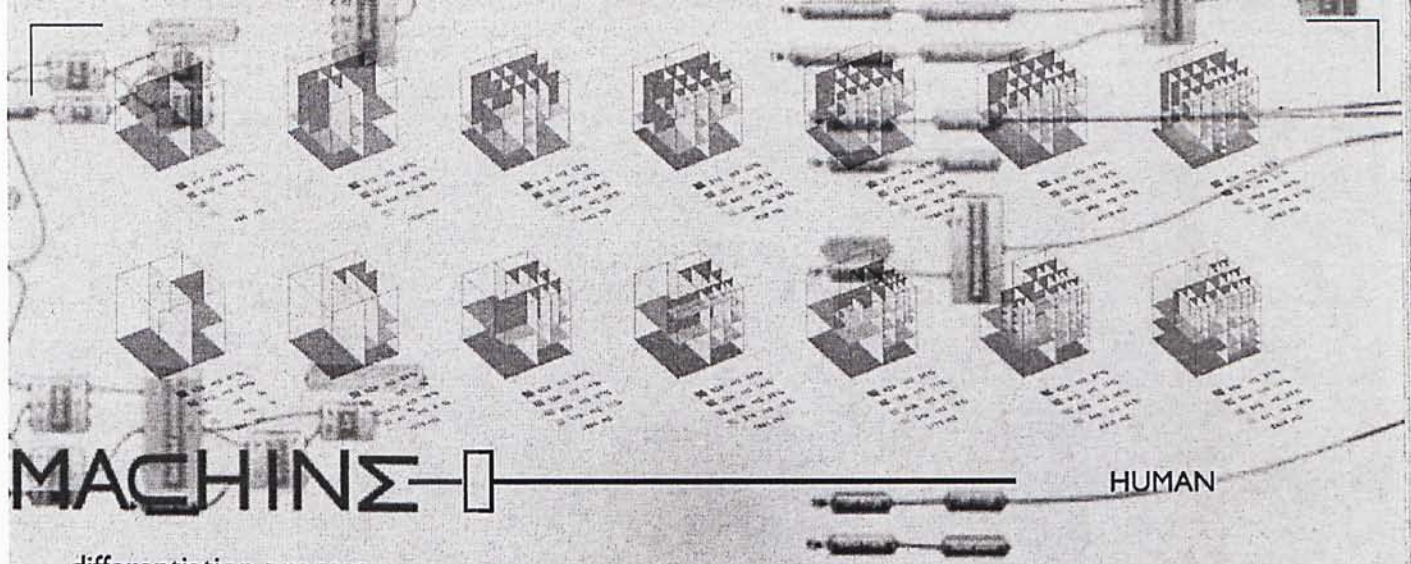
MACHINΣ



HUMAN

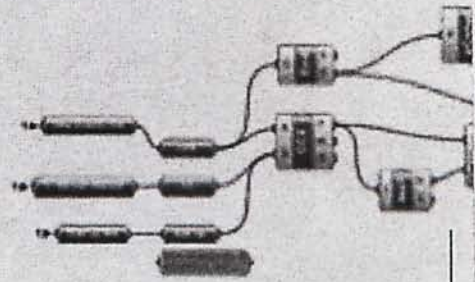
principle variable parameter 3

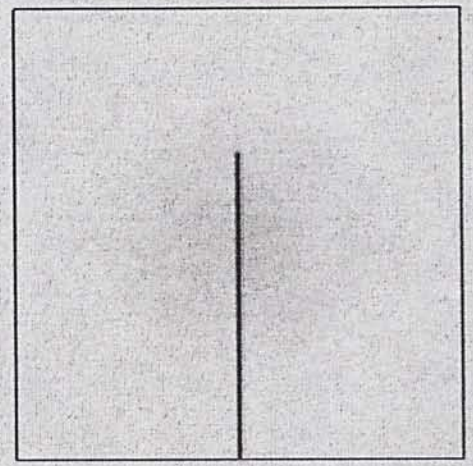
+ Subdivision Proportion



differentiation process

+ Number of Differentiation
+ Acceleration Rate



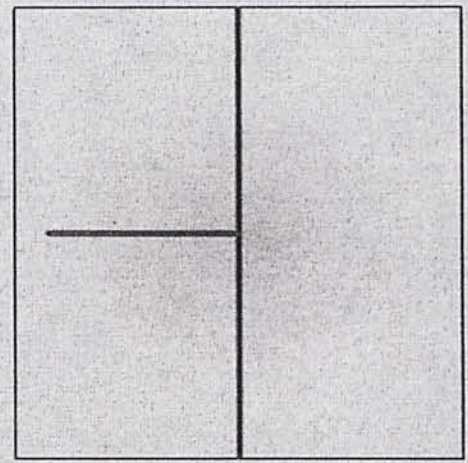


Major subdivision

differentiation process

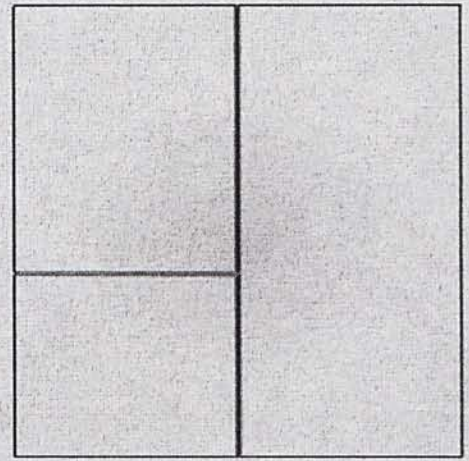
1st subdivision

Branch out to divide
into 2 smaller spaces



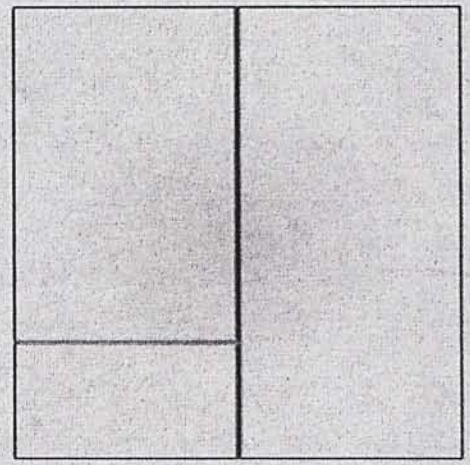
differentiation process

1st subdivision



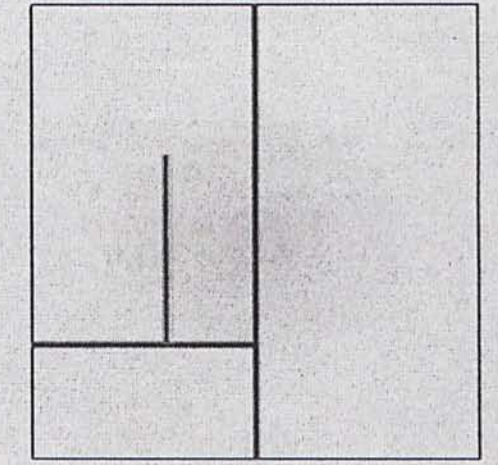
differentiation process

2nd subdivision



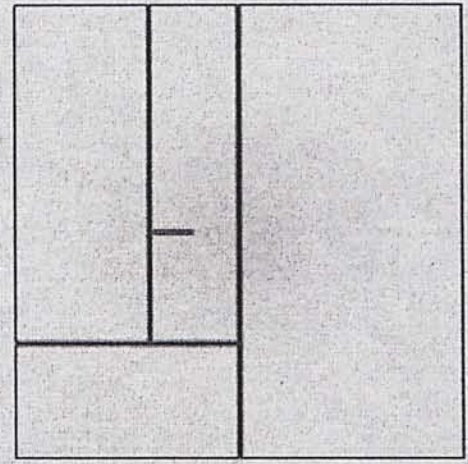
differentiation process

2nd subdivision



differentiation process

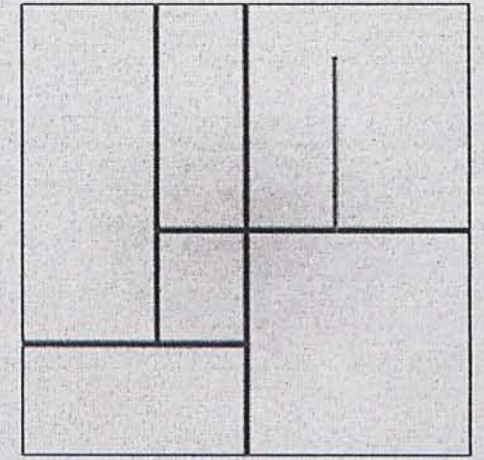
2nd subdivision



Branch out to direction
opposite to the previous

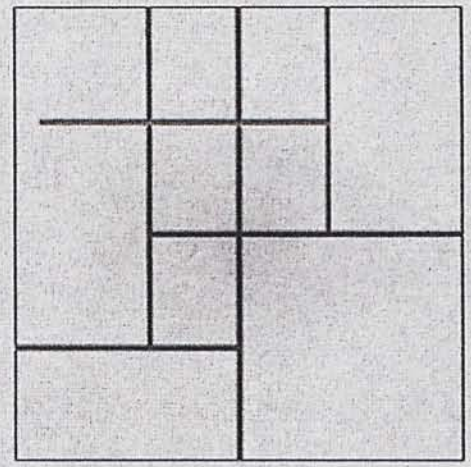
differentiation process

2nd subdivision



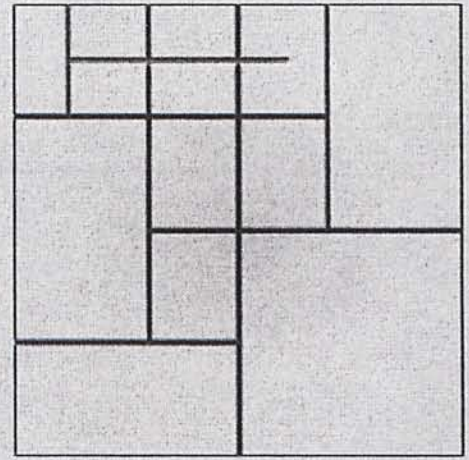
differentiation process

3rd & 4th subdivision



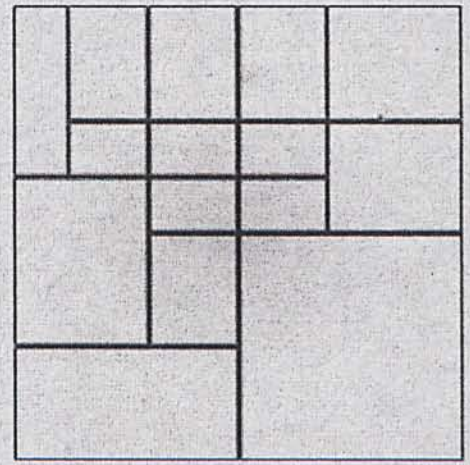
differentiation process

3rd & 4th subdivision



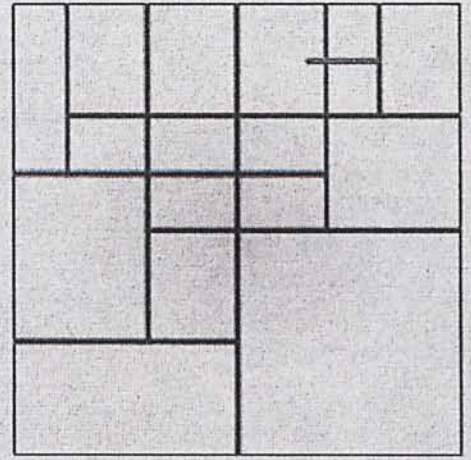
differentiation process

3rd & 4th subdivision



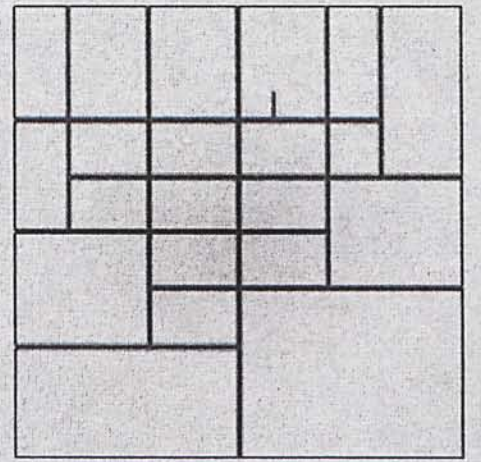
differentiation process

5th subdivision



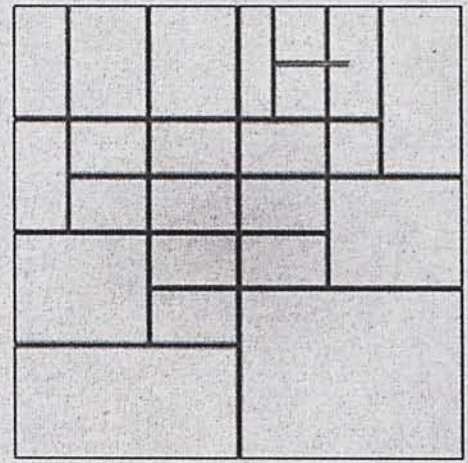
differentiation process

5th subdivision



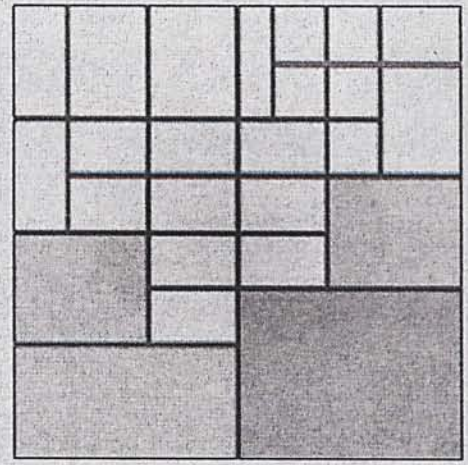
differentiation process

6th subdivision



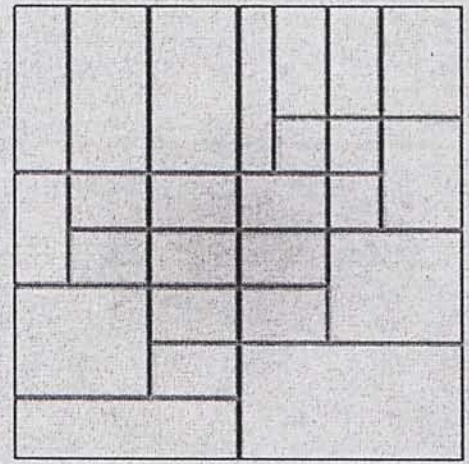
differentiation process

6th subdivision



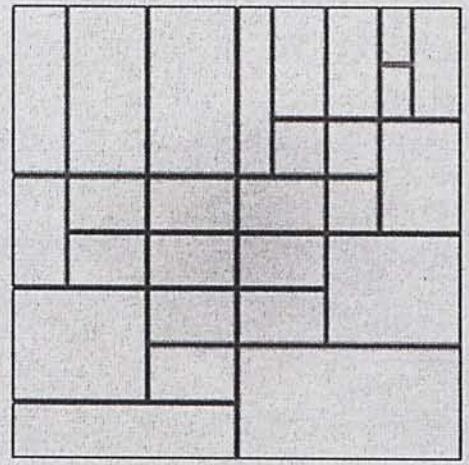
differentiation process

6th subdivision



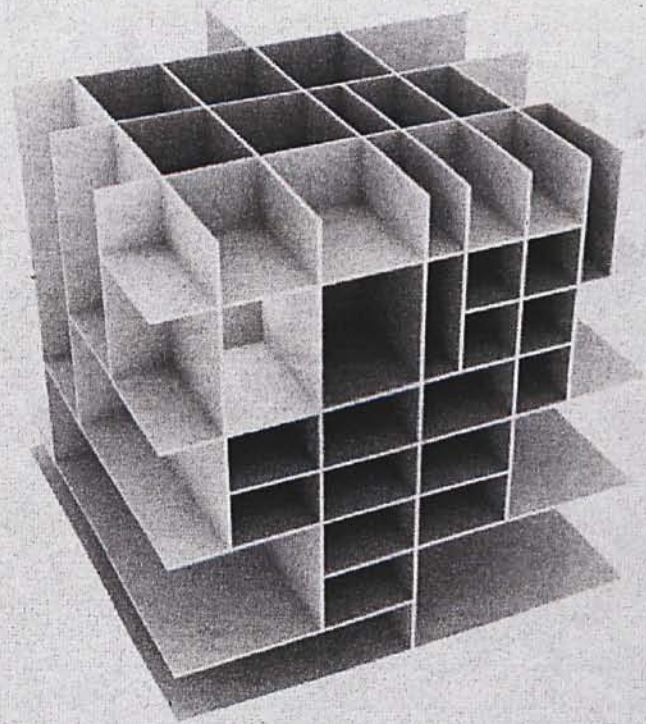
differentiation process

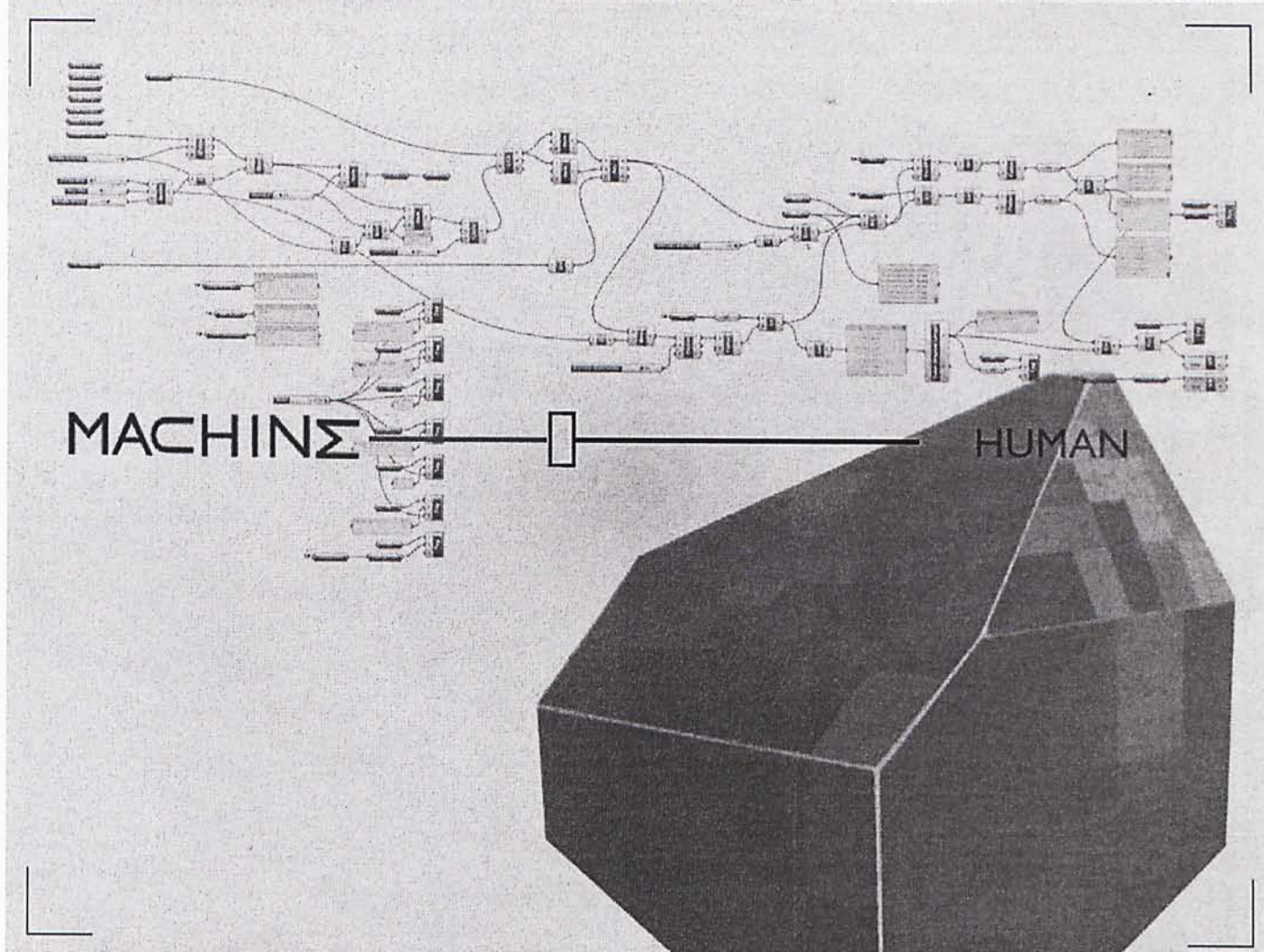
7th subdivision

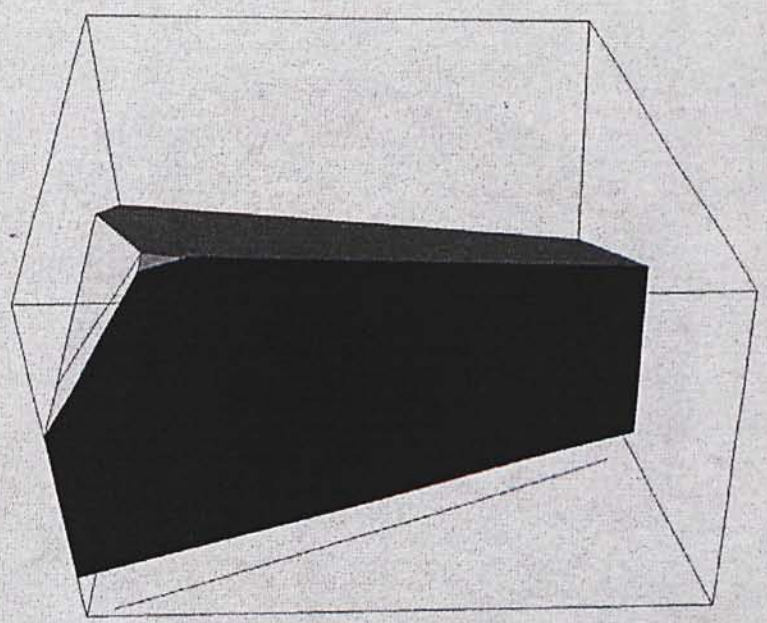


differentiation process

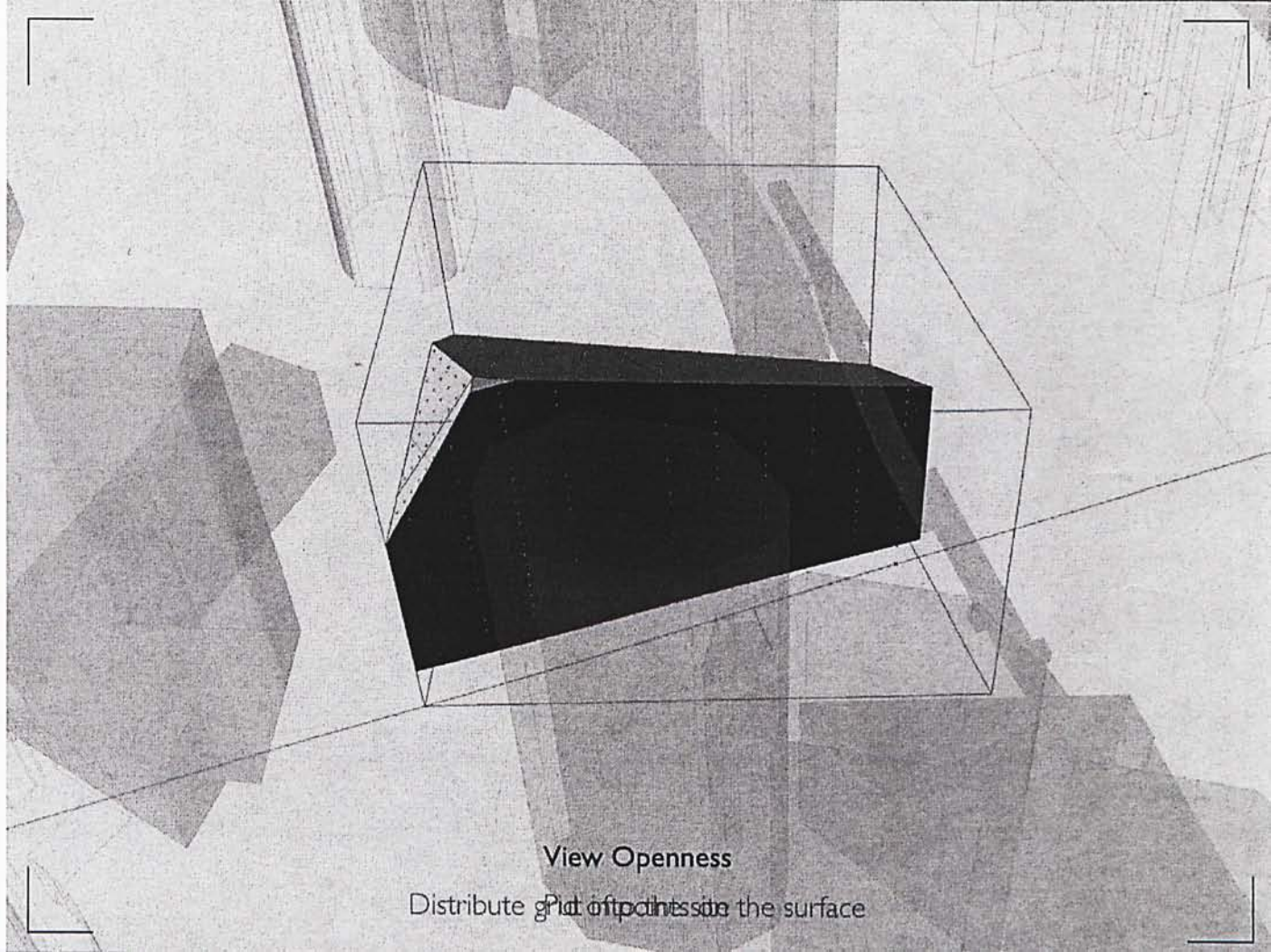
7th subdivision




MACHINΣ
HUMAN

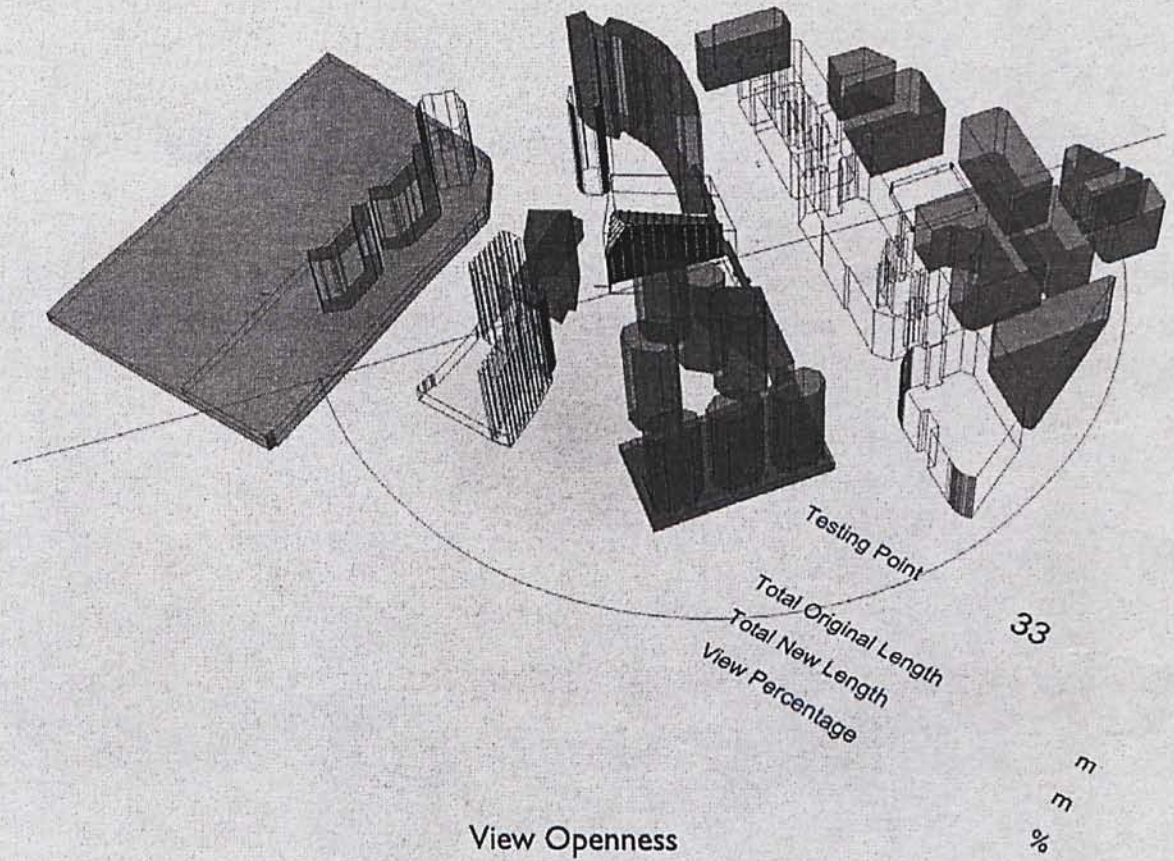


View Openness



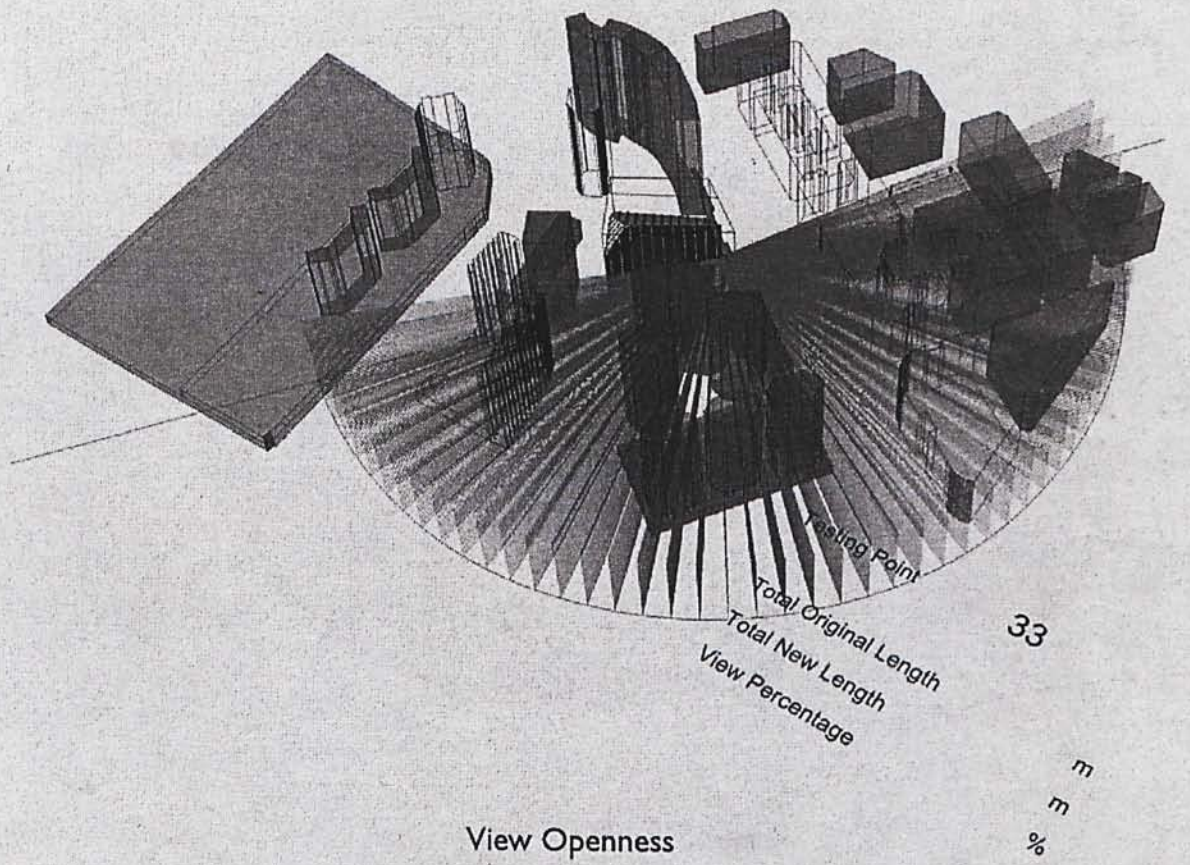
View Openness

Distribute grid points on the surface



View Openness

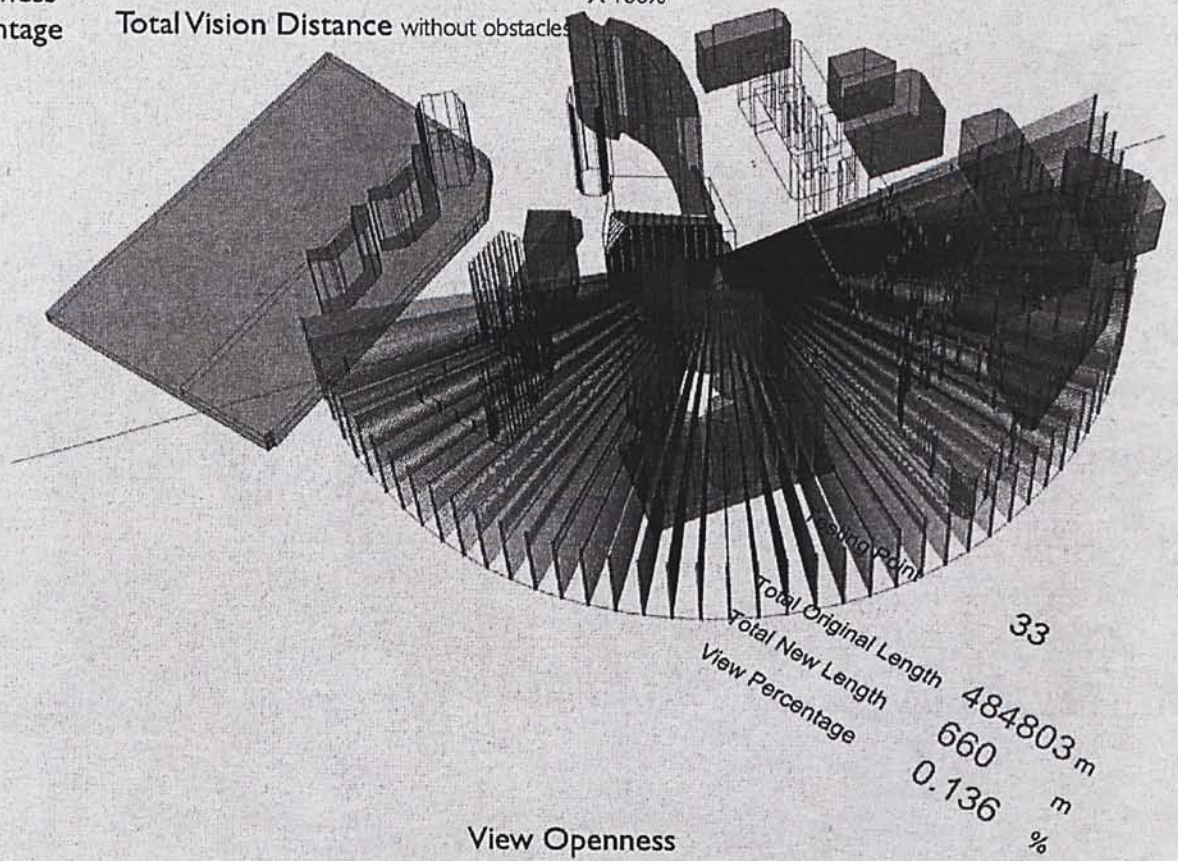
Extend lines out from one of reference point



View Openness

Extend lines out from one of reference point

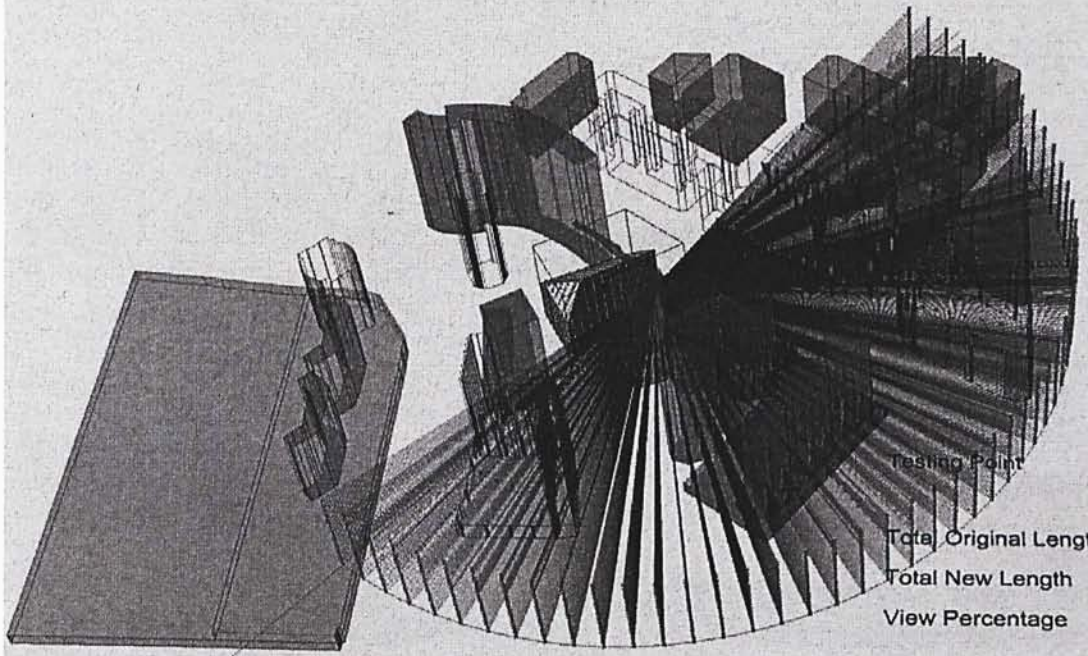
$$\text{View Openness Percentage} = \frac{\text{Total Vision Distance with obstacles}}{\text{Total Vision Distance without obstacles}} \times 100\%$$



View Openness

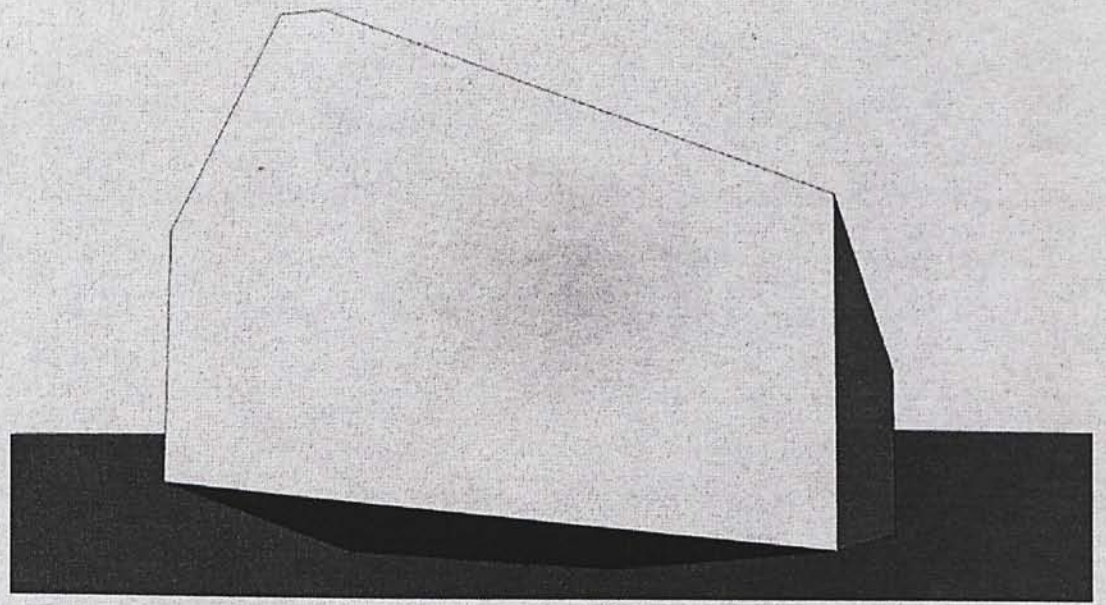
Calculate View Openness Percentage

$$\text{View Openness Percentage} = \frac{\text{Total Vision Distance with obstacles}}{\text{Total Vision Distance without obstacles}} \times 100\%$$



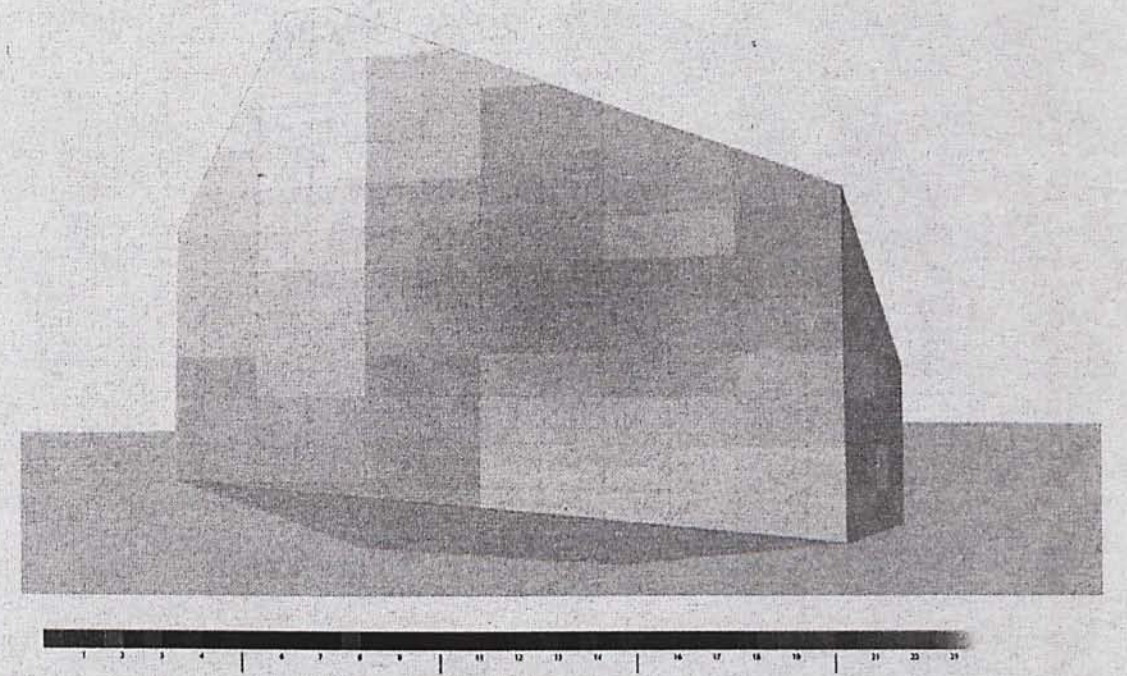
View Openness

Calculate View Openness Percentage



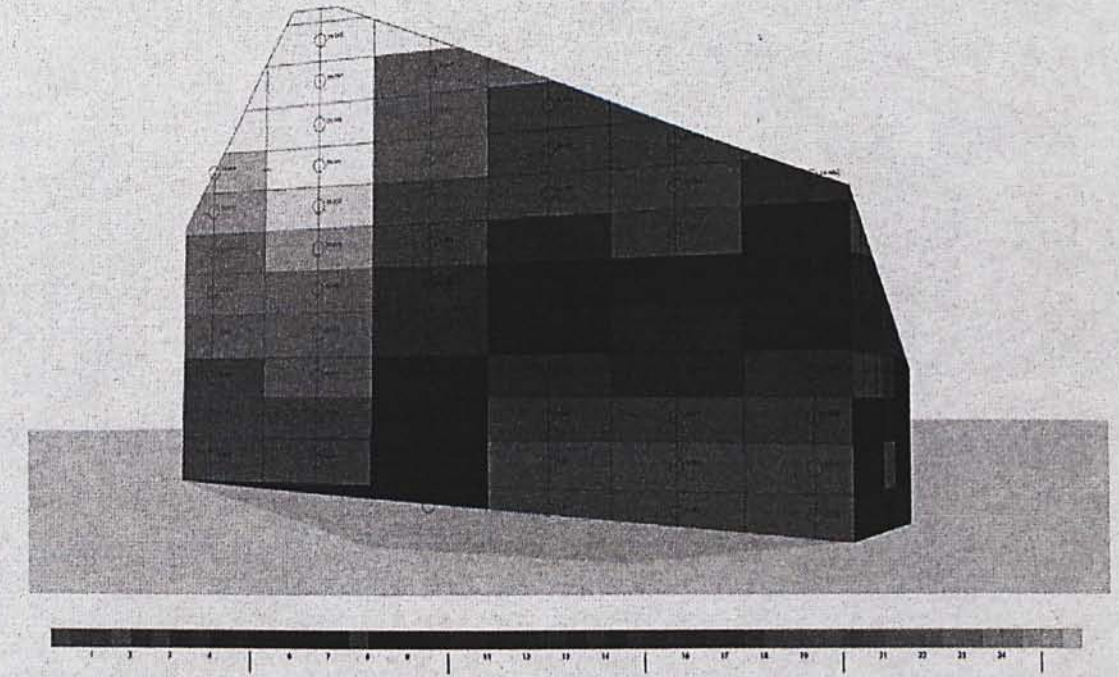
differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



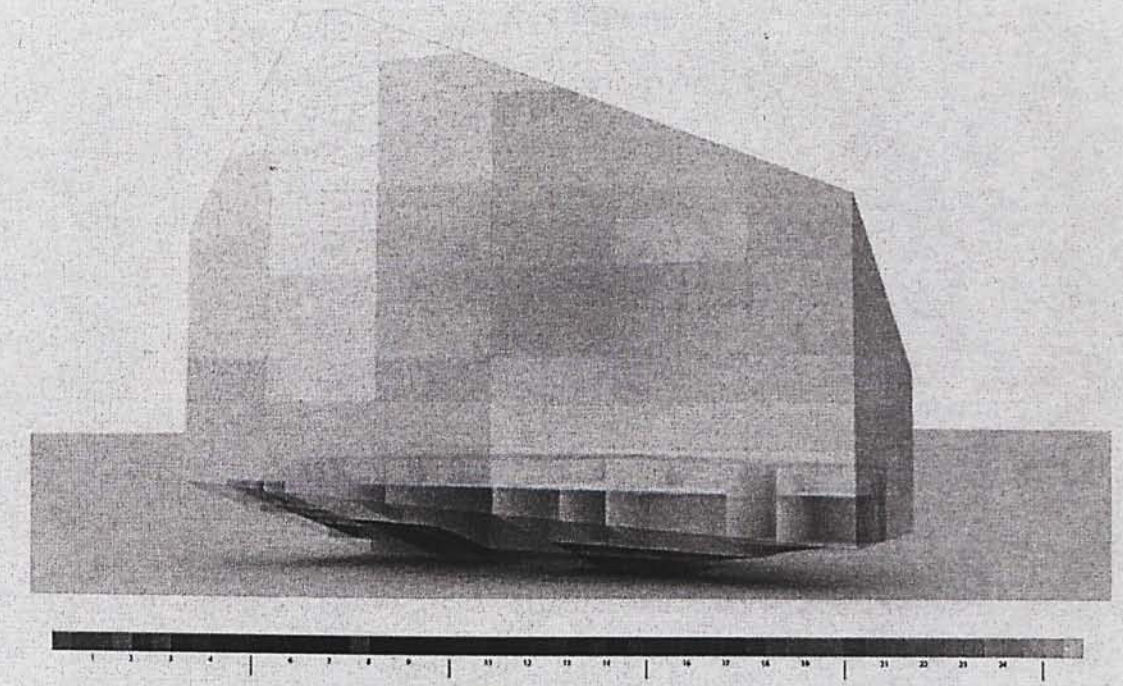
differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



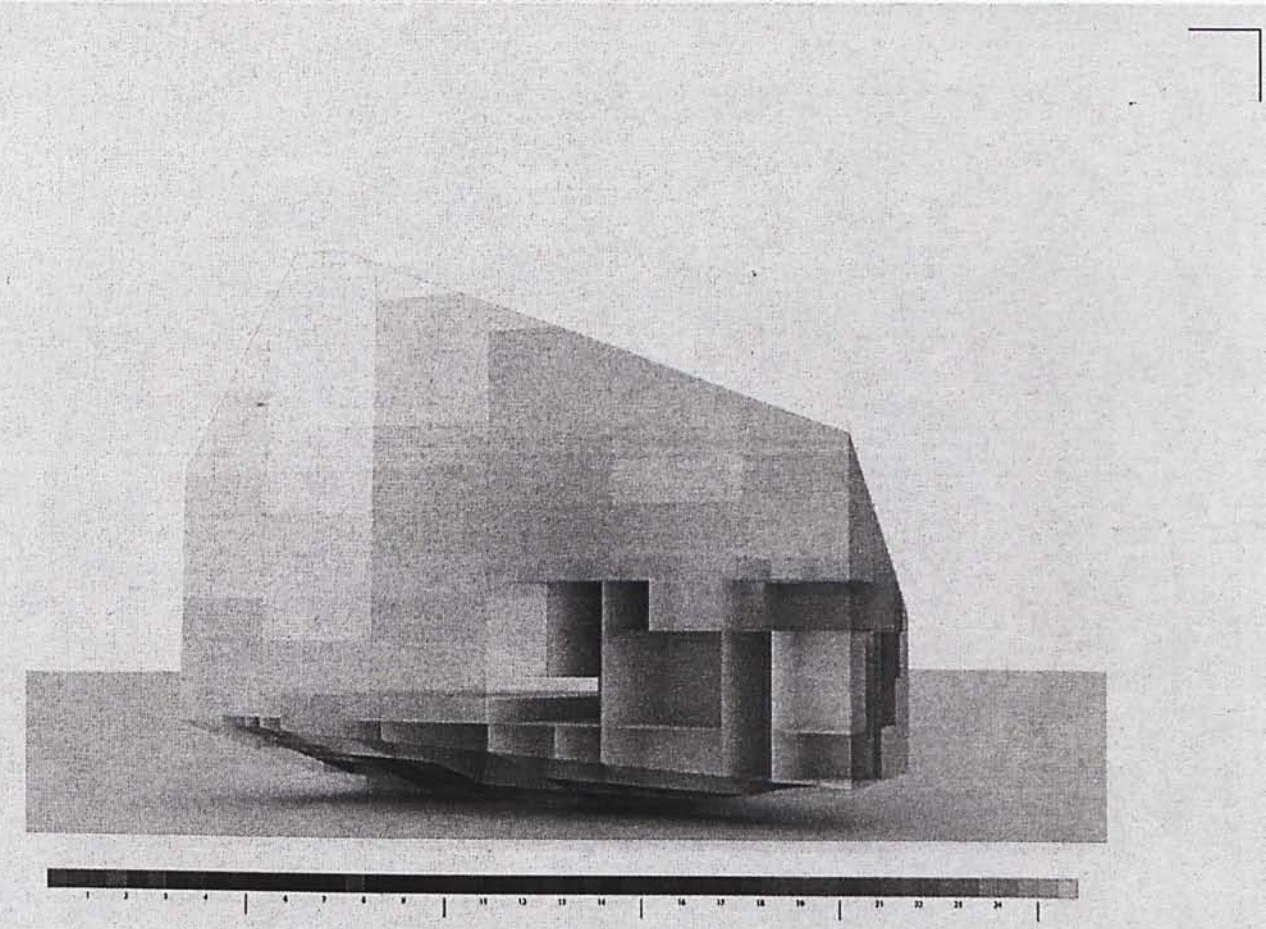
differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



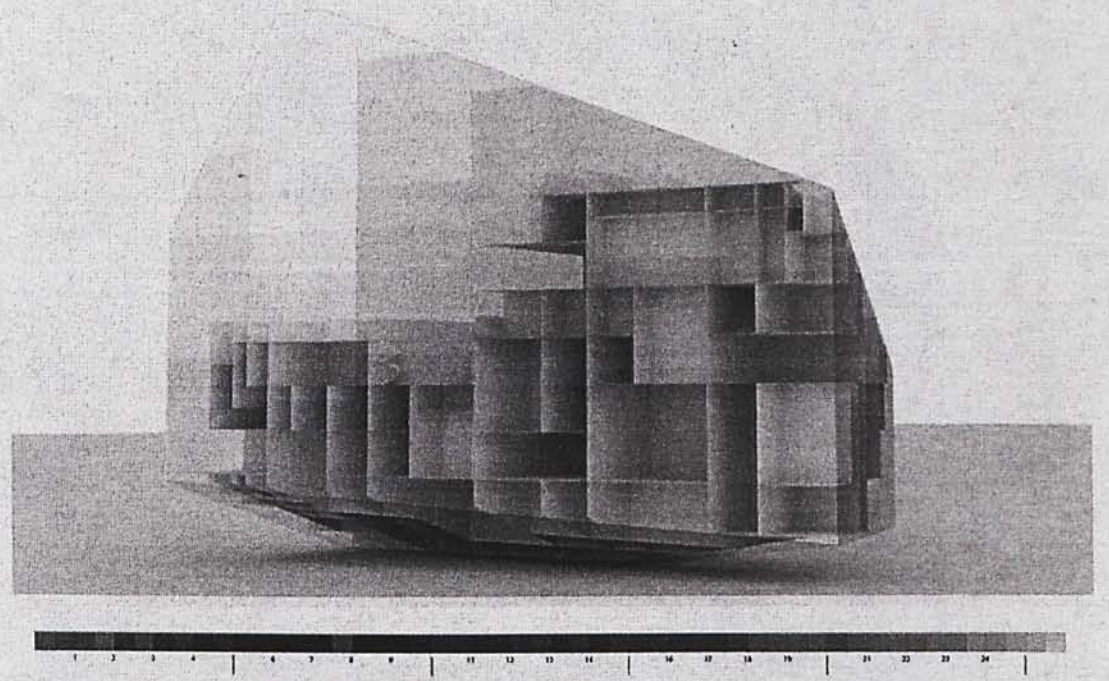
differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



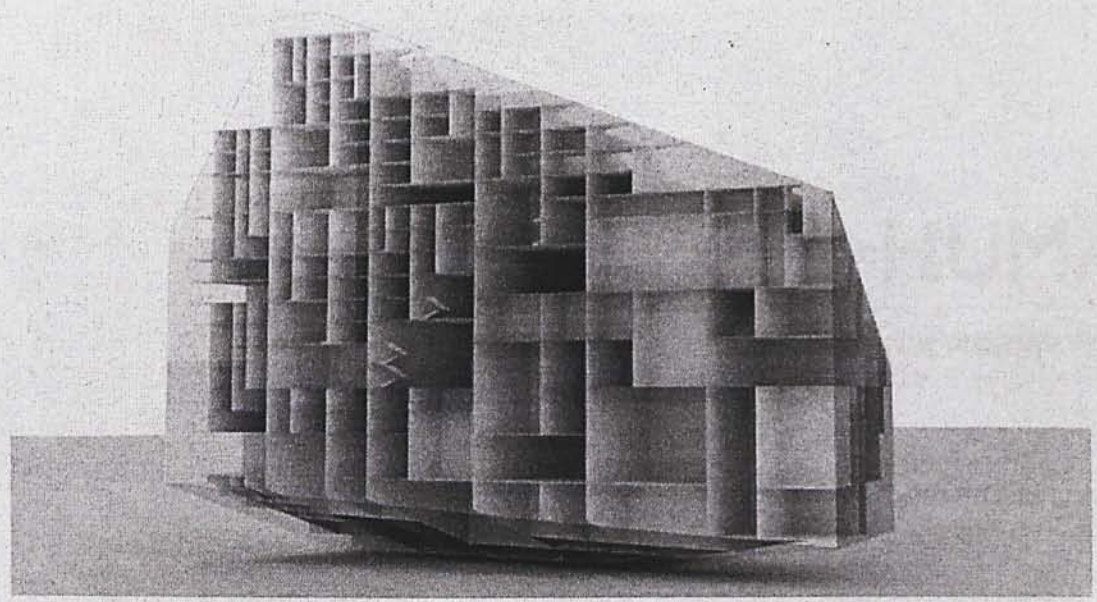
differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



differentiation in the whole mass

View Openness Percentage Value => Density of Subdivision



differentiation in the whole mass

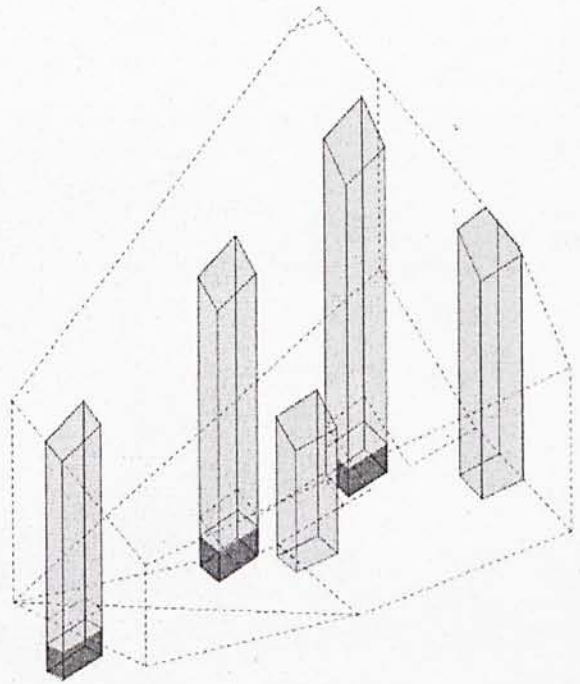
View Openness Percentage Value => Density of Subdivision

MACHINΣ

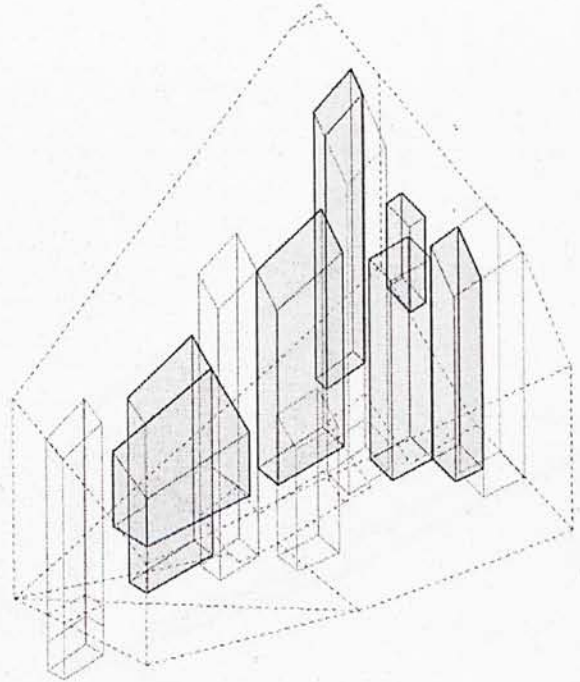
HUMAN

building program distribution

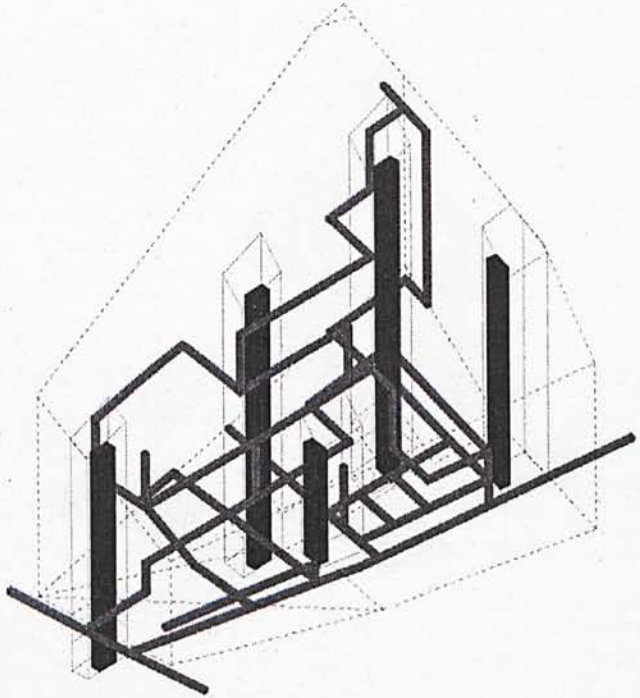
+ Air
+ Light
+ Room Proportion and Size
+ Accessibility



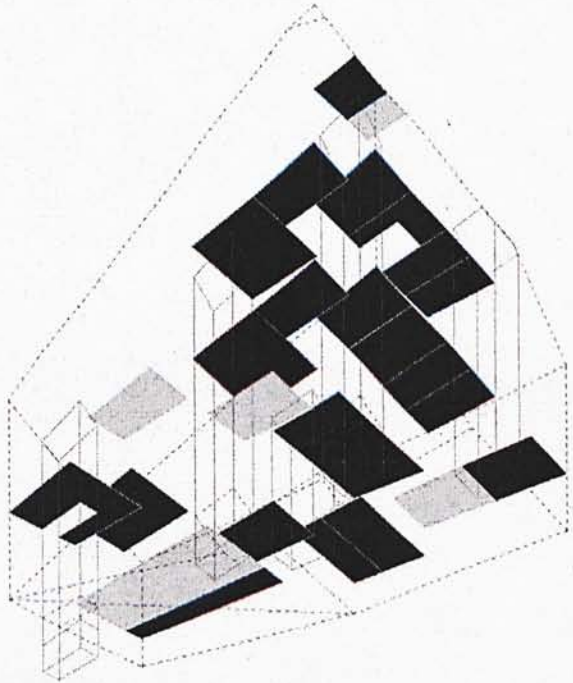
Cores



Voids



Routes



Major Programs